Power Engineering

OCTOBER, 1951

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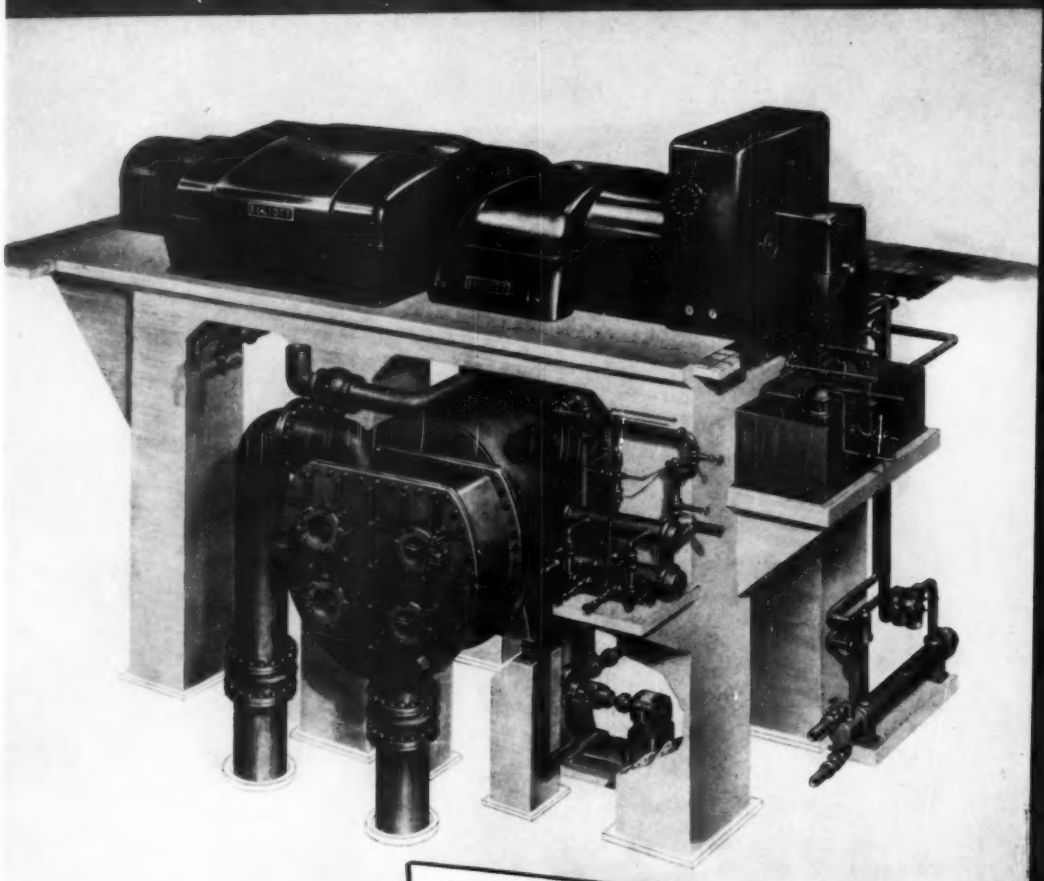
TECHNICAL PUBLISHING COMPANY 1 CHICAGO, ILLINOIS

Driving ahead



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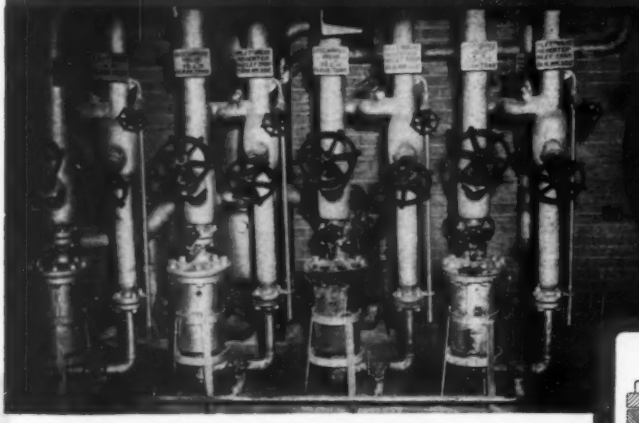

List of Materials

CAP and BODY FORGINGS:*
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600 to 900 psig—ASTM F-1 moly-steel
900 to 1500 psig—ASTM F-7 chrome moly-steel

VALVE AND SEAT:
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BUCKET and VALVE LEVER ASSEMBLY:
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BOLT and NUT SET:*
Bolts Class C, 125,000 lbs. tensile
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● FOR COMPLETE DATA ask for the 36-PAGE ARMSTRONG STEAM TRAP BOOK or see our catalog in Sweet's.

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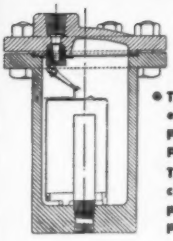
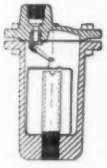


● Traps with screwed connections for pressures to 900 psig.

Traps with flanged connections for pressures to 2400 psig.



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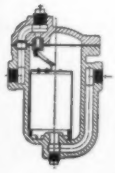

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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

This magazine was established in 1896 as Practical Engineer. The title was changed to POWER PLANT ENGINEERING in 1918, to POWER GENERATION in 1948, and to POWER ENGINEERING in May, 1950. Rights reserved to above titles

October, 1951

VOLUME 55 — NUMBER 10

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Backed by the E.C.A. and built of American equipment and materials but with native labor in the Damodar Valley of India, Bokaro represents the latest and best in American practice for its temperature and pressure range.

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The air-cooled condenser makes it possible to operate condensing equipment when adequate water supply is not available. Many of our readers now have or may some time have that situation. The article gives actual working details.

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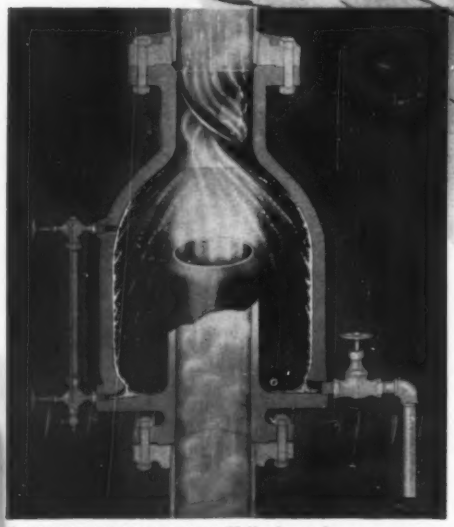

1 THE WHIRL DOES THE TRICK! Helix, located near separator inlet, imparts positive whirling motion . . . removes entrained liquids, solids, oil or grease from live or exhaust steam, from air or chemical vapors—*virtually without pressure loss.* Swartwout separators have no baffles, plates, grids or other parts to cause flow reversals, velocity heads or vibration. Vertical separators, above, for up flow or down flow, supplied in 50 to 600 lb. standards.

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ENGINEERS' PREVIEW

IF YOU KNOW or have one of those boys who has aspirations of becoming a great creative engineer — better tell him to start boning up on his geometry. One of the nation's top-ranking inventors says that ability to solve geometry problems is the best intelligence test for creative engineering ability.

Dr. Ernst F. W. Alexanderson, radio and television pioneer, who was recently awarded his 320th patent for inventions made during his 49 years with GE, explained that algebra can be figured by routine rule, while the solution of geometry problems requires the use of imagination. "If an intelligence test for engineering should be adopted, I would say that the ability to solve geometry problems should be the first consideration," he said.

★ ★ ★

REVOLUTIONARY new method of detecting the presence of corrosion before it damages industrial and other installations will be among the important advancements in electrochemistry announced at the semi-annual meeting of The Electrochemical Society, Inc., at the Hotel Statler in Detroit, October 9–12. The new process called "Rotogenerative Detection" is based upon the use of electrical currents to determine incipient weaknesses in the metal and future points of corrosion so that preventive measures can be taken. The developers of the process, J. B. McAndrew, W. A. Colner, and H. T. Francis of Armour Research Foundation, will outline its benefits. Other major topics will include a discussion of the corrosion of aluminum and its prevention by H. H. Uhlig and his associates of the Massachusetts Institute of Technology Corrosion Laboratory.

★ ★ ★

NEW NON-INFLAMMABLE hydraulic fluid gives promise of eliminating the fire hazards now associated with many industrial hydraulics systems and hydraulically operated machines. Known as H-2 Non-Inflammable Hydraulic Fluid, the new product was developed by Hollingshead research chemists in cooperation with the U. S. Navy's Bureau of Aeronautics which had been experimenting on water-glycol fluids for a number of years. H-2 is now being used in most Navy aircraft.

Storage — Should be kept in the original containers and they should be kept closed.

Contamination — The fluid should not be contaminated with ionizable materials which might reduce the effectiveness of some of "H-2's" additives.

Cleaning System Parts — Hydraulic system parts exposed to "H-2" should not be cleaned with chlorinated hydrocarbons (carbon tetrachloride, tri-chlorethylene, etc.)

Pipe Sealants and Dopes — These should not contain any metallic constituents such as lead which might be dispersed throughout the system by "H-2".

Painted Surfaces — Care should be taken not to spill "H-2" on painted surfaces although no damage will result if it is rinsed and wiped off within three or four hours.

Effect on Plastics — "H-2" has little or no effect on most common plastics. However, it is recommended that the identity of a given plastic material be established and tested in order to insure satisfactory performance with the new fluid.

Electric Wire Coating — No harmful effect on vinyl or fiber-glass wire coatings and insulating materials by "H-2" has been found, provided they are properly fabricated.

TO HELP INDUSTRY get the most productivity from its existing facilities, a new plan has been announced by the General Electric Company.

Called Productive Maintenance, the plan is designed primarily to assist maintenance engineers in setting up a program to minimize lost production time and forced idleness due to equipment failures. In addition, it will provide better spare parts control, smoother production flow, and enable industry to gain optimum output from existing equipment, according to G-E engineers who worked on its development.

To help the maintenance engineer materially, the Company offers a Productive Maintenance Kit, a file-size package of maintenance aids to guide him in setting-up a working program. The kit contains an instruction bulletin, a typical balance sheet for keeping historical data on each machine, planned outage forms, and checklists for motors, control, and other equipment. To supplement the kit, a new slidefilm, "Productive Maintenance", will be available this fall for showing through the local G-E offices. The film explains how Productive Maintenance can benefit every industrial plant.

★ ★ ★

ORDINARY ROCK SALT, used as a cloud-seeding agent, may prove an effective tool in man's attempts to control the fall of rain, says G-E weather scientist Dr. Vincent J. Schaefer. It might be used to prevent rain along certain normally-rainy coastal regions and enable cloud moisture to be transported to areas further inland before falling as rain. According to the G-E scientist, certain salts, in fine particle form, have an ability to attract and collect the tiny molecules of water vapor which are present both in clouds and in open air and, in collecting them, can virtually grow tiny raindrops heavy enough to fall. These raindrops similarly can sweep up or collect droplets in their path, resulting in full-fledged raindrops and general rainfall.

It is believed that nature uses these salts in such fashion to produce much of the consistent rains in coastal areas, since clouds and air blown in from the sea contain salt particles.

★ ★ ★

VITAMIN B 12 — a crystalline organic compound used to combat pernicious anemia — has been subjected to neutron bombardment in the research reactor at Brookhaven National Laboratory and made radioactive for use as a research tool.

The method of preparation changes the cobalt 59 atoms, contained in the crystalline vitamin, into radioactive cobalt 60 atoms, which for the most part are retained in biologically active — and intact — molecules. This method should make radioactive B 12 readily available as a tracer for such biological research as the study of the relation of the vitamin to blood formation.

★ ★ ★

TWO-WAY radio system, believed to be the first in the country to be used exclusively for plant protection, will be installed at the Schenectady, N. Y. Works of the General Electric Co. The network will include 35 base stations in guard posts throughout the 600-acre Schenectady Works and seven mobile stations installed in plant police cars, fire trucks, and ambulances. This system will make the G-E plant one of the best protected in the country.

TODAY'S higher operating pressures in boilers, and higher rates of heat transfer, require that water treatment be controlled within narrow limits. Determination of the alkali metals in waters and deposits is an important step toward accuracy of these analyses. Application of the flame photometer in the rapid determination of these metals was described by R. K. Scott, V. M. Marcy, and J. J. Hronas, analytical chemists of Hall Laboratories, Inc., at the annual meeting of the ASTM on June 19 in Atlantic City. Determinations can be made in a few minutes, rather than the 2 to 2½ hr of the older methods. Though results are obtained rapidly, they are of sufficient precision and accuracy for all control applications.

★ ★ ★

READERS who have been following some of the legal aspects of the power industry, as presented in these pages by Albert Woodruff Gray (see Public Utility Anti-Strike Laws Declared Invalid, September issue, and others), may have come to the conclusion that sometimes the courts seem to have systems of logic peculiarly their own. For example, on the question of overcharged wires, the courts' reasoning apparently is that the wire is dangerous and for that reason the danger should be abated irrespective of inconvenience to others.

In that connection, Mr. Gray tells us what he claims is the funniest decision he ever encountered along this line. A man sold a horse on a conditional sales agreement. When he didn't get his pay he sued and levied on the horse. The horse was then sold and the proceeds applied to the debt. But the proceeds were not sufficient to pay the full debt, therefore, legally, it remained unpaid. So the seller demanded return of the horse according to the agreement. The buyer couldn't return the horse — the animal was gone. Then the seller had the buyer shut up in jail for conversion — that is, dealing with the property of another as if it were one's own, without right.

★ ★ ★

HYPERSONIC pilot plant transducer, manufactured by the Brush Development Co., is being installed at a paper mill to remove particles of suspended fibers from waste water. A transducer, as you will quickly remember, is a device for transforming power in one system, such as an electrical system, into power in another system, such as a sound wave system. The transducers in question produce very high frequency or ultrasonic vibrations and this marks the first industrial application of such ultrasonic equipment to a liquid. Paper waste problem has caused the industry extreme concern. The superfine paper particles are so small they cannot be screened out. Up to now they have been dumped in streams, killed fish and caused complaints of pollution. This and other ultrasonic devices for precipitating materials from aerosols, and their possibilities in cleaning various types of gases, were discussed in the article Where Will Ultrasonics Fit in the Power Field? September 1949 issue.

★ ★ ★

MOST REFRACTORY materials, of course, are dense and heavy by nature. However, when severe abrasion becomes a factor in their performance, density must be increased as much as possible without affecting heat- and crush-resistance. Dow Corning Silicone Antifoam A Emulsion helps one manufacturer attain this effect by preventing the formation of bubbles in the original mix, thereby eliminating air pockets in the finished brick. So far as can be detected, no trace of silicone remains in the finished brick.

REPORT of the Locomotive Development Committee of Bituminous Coal Research, Inc., submitted by John I. Yellott, Director of Research and Peter R. Broadley, Assistant Director of Research, has just been issued covering the period May 1, 1950 to April 30, 1951. It is an 8½-by-11-in., 44-page booklet, packed with the latest technical information about the development of the coal-burning gas turbine, on which Mr. Yellott and his associates have been working. A number of the principal developments reported for this year were explained by Mr. Yellott in his article Coal-Burning Gas Turbine Steps Ahead Fast in 1950 and 1951, in the July issue. But the complete report contains a great deal more technical data and illustrations than the article. The report is not only a masterpiece of technical exposition but also a splendid job of layout and illustration and printing.

★ ★ ★

OUR UNIVERSITIES and technical colleges and those of Great Britain provide admirably for the basic technical training for the scientists and engineers necessary for the industrial outputs of those countries. But there is only one establishment in the world, so far as we are aware, that is devoted exclusively to the teaching of gas turbine technology.

That establishment is the School of Gas Turbine Technology operated by the British nationally-owned power jets (Research and Development) Ltd. It is located in a large country house in Farnborough, Hampshire, England, and its principal, D. L. Brown, explains all about it in the July 1951 issue of *FBI Review*. That is the Journal of the Federation of British Industries and not, as you might at first suppose, a publication of our Federal Bureau of Investigation.

The courses given in the School of Gas Turbine Technology are divided into two general groups: Design Courses of Post Graduate Standard; and Practical Courses dealing principally with construction, installation and maintenance. Although the school has been in operation now for over 7 yrs, it feels it is still in its infancy and looks forward to a very promising future. The school normally is restricted to students from the United Kingdom and the Commonwealth, but also provides a design course two or three times a year especially for students from overseas.

★ ★ ★

REPORT on machinability of high-temperature alloys is featured in the current issue of the *Technical Reports Newsletter*, released by the Office of Technical Services of the United States Department of Commerce. The report covers one phase of a U. S. Air Force research program to determine requirements for the highest production at the lowest cost in the machining of metals, and presents unpublished data on the best way to machine high-temperature alloys, cast iron and steel in view of their microstructures. Single copies of the August, 1951 *Newsletter* are available without charge from the Office of Technical Services of the United States Department of Commerce, Washington 25, D. C. or from the United States Department of Commerce field offices.

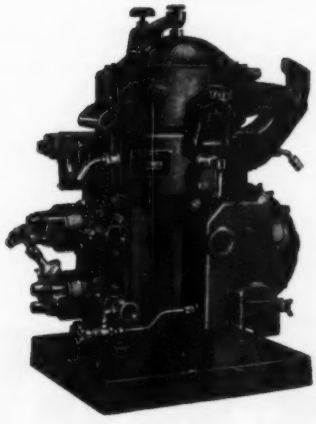
★ ★ ★

EMPHASIZING the importance of properly applied electrical equipment for increased production, a travelling industrial power exhibit is being sponsored by Westinghouse Electric Corp. and its distributors. The exhibit, called More Production Ahead now is on a tour of industrial centers as a part of a planned power-distribution program.

KEEP AWAY FROM DOUBLE TROUBLE WITH A DE LAVAL OIL PURIFIER

Some "trouble" may not be as bad as it sounds, but turbine lubricating oil difficulty is best prevented right from the start. Centrifuging the oil by means of a De Laval Oil Purifier is the surest way to have a full supply of clean lubricating oil circulating through the system. The De Laval machine removes by means of centrifugal force both the solid and the liquid impurities that impair the usefulness of the oil.

All of the dirt is thrown out of harm's way and stored in the bowl until it is ready to be cleaned. Any water present is instantly and continuously discharged to waste.



De Laval centrifuges do not remove any oil-soluble additives. Since most turbines have comparatively little water trouble, the amount of inhibitor of any kind that is lost is inconsequential. It is important, however, to note that should a leak occur, the De Laval provides the necessary means of getting rid of the excess water instantly.

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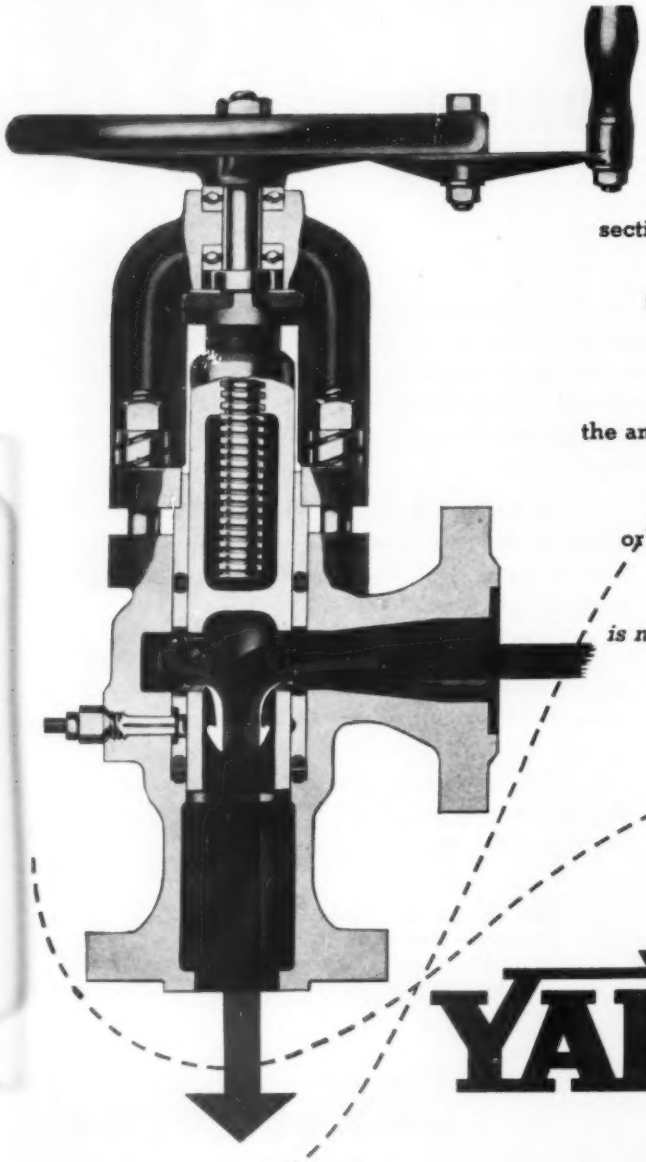


Take a look at these two sectioned pictures of a Yarway Seatless Blow-Off Valve. They show the reasons why more than 15,000 boiler plants use Yarways.

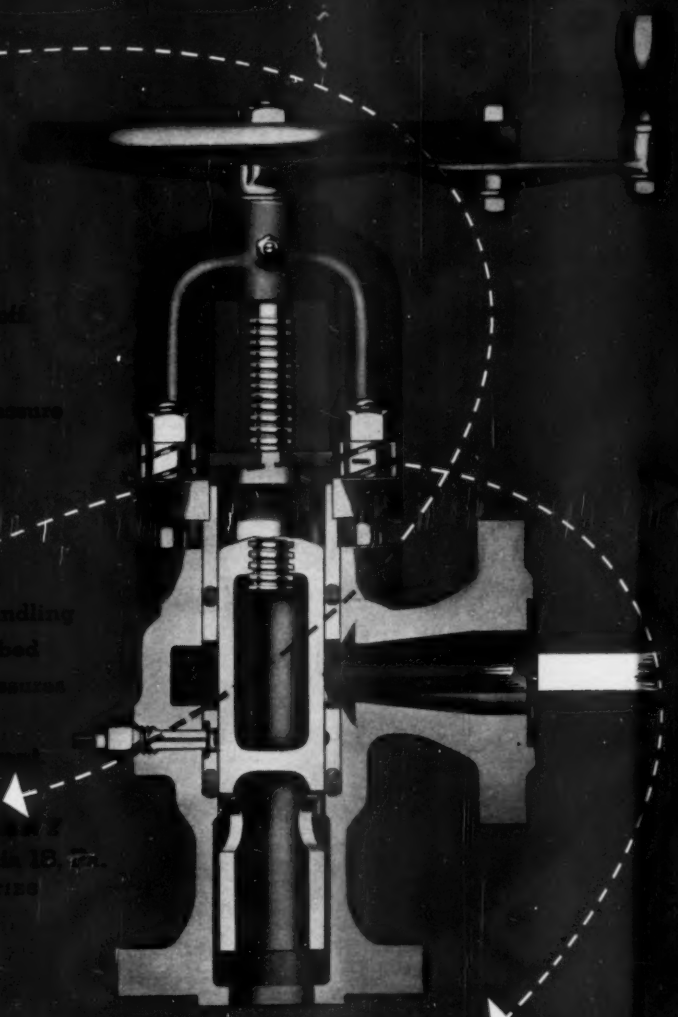
Notice in the open valve, at left, the ample space provided for free flow of blow-down through the hollow plunger. There are no projections or pockets to catch scale or sediment.

Notice particularly that *there is no seat to score, wear, clog or leak.* That most troublesome part of a blow-off valve has been eliminated!

YARWAY

KEEP BOILERS ON THE

SHUT CASE



Now look at the closed valve, at right. In this position, packing rings are compressed around plunger, insuring drop tight shut-off.

Tension springs under the yoke nuts help maintain continuous pressure through the glands on packing rings, keeping the valve tight.

There are other reasons, too ... such as nitralloy plungers, special metallurgical improvements for handling acid wash, etc. They are all described in Yarnall Bulletin B-423 for pressures to 400 psi, or B-433 for higher pressures. Write for the one you want.

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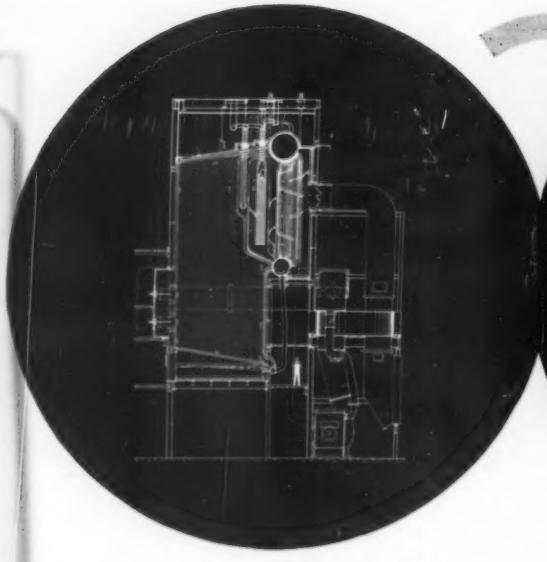
114 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

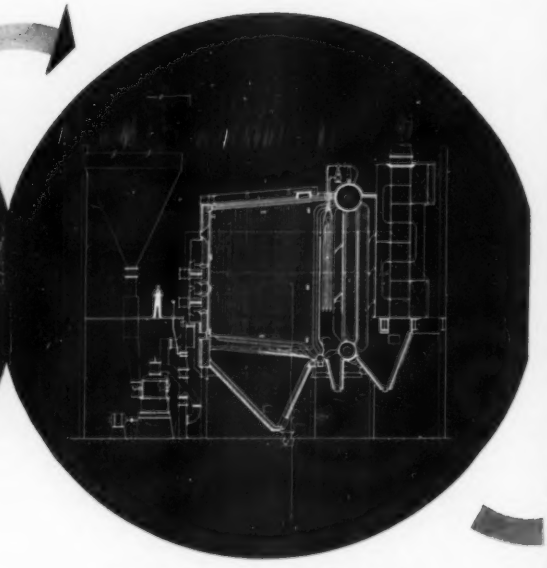
BLOW-OFF VALVES

BY STOPPING BLOW-DOWN TROUBLES AT THE

Are VU Boilers habit forming?



VU-50 Boiler fired with oil. The capacity of the unit shown is 350,000 lb of steam per hour; operating pressure—920 psi; total steam temperature—905 F.



VU-50 Boiler fired with pulverized coal. The capacity of the unit shown is 150,000 lb of steam per hour; operating pressure—625 psi; total steam temperature—760 F.

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS, ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

The record shows that they are. More than 100 companies . . . large and small . . . throughout this country and abroad . . . have ordered VU units more than once. Nearly half of these have ordered more than twice. Some as many as 5 or 6 times.

Considered in light of the fact that Vertical-Unit Boilers have never been — nor are likely to be — the cheapest you can buy, such a record becomes even more significant.

Here are just a few examples of the many industries that appear to have formed the VU habit.

A Steel Company now has a total of eleven VU Units in three different plants. Starting with an initial installation of three units in 1940, it has reordered twice; three units for a second plant in 1946 and five units for a third plant in 1950.

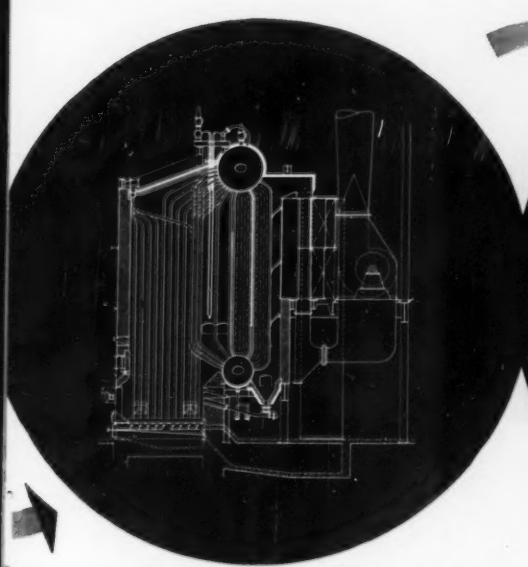
An Electric Utility Company started using the VU in 1944 when two units were installed at one of their power stations. When the capacity of this station was increased in 1948 two more units were installed. In 1947 this company ordered two more units for another of its stations.

An Oil Company ordered its first VU in 1937, its second in 1938. In 1942 another VU was installed and still another in 1944.

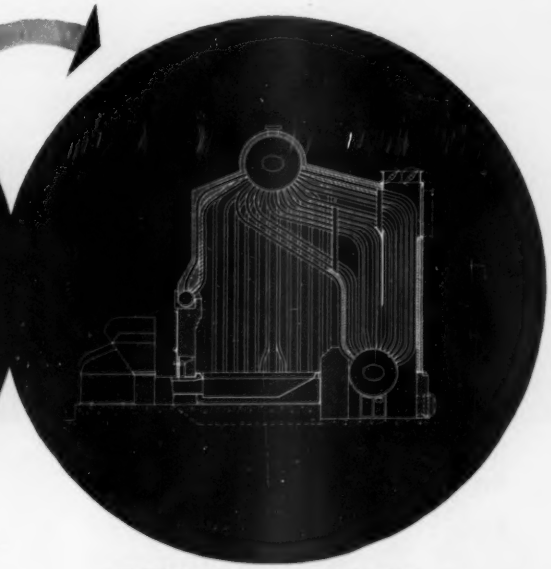
An Aluminum Company is another consistent buyer of VU Units. Since installing its first VU in 1940, it has reordered four times, and now has five C-E Vertical-Unit Boilers in service.

* * *

Just a small sample to be sure, but one that can be repeated over and over for other industries and other companies . . . companies that have ordered and reordered VU Boilers . . . companies that have the "VU habit" and find it highly profitable. B-511



VU-50 Boiler as adapted for firing bagasse on a C-E Spreader Stoker. The capacity of the unit shown is 75,000 lb of steam per hour; operating pressure—160 psi; total temperature—530 F.



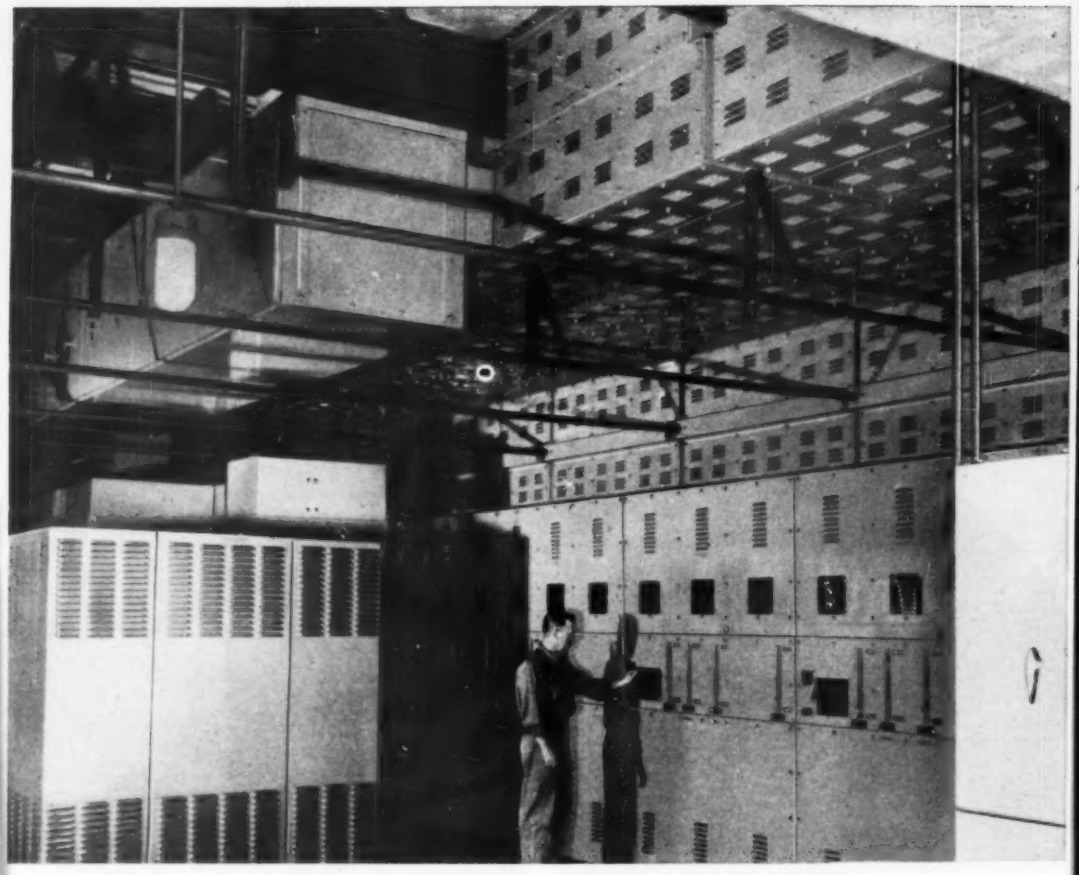
VU-10 Boiler fired with C-E Skelly Stoker. VU-10 Boilers range in capacity from 10,000 to 60,000 lb of steam per hour. They may be fired by underfeed, spreader or chain grate stokers or by oil or gas.

— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

C-E

Switchgear for your entire station



COMPLETELY METAL-ENCLOSED COMPONENTS INSTALLED AS A UNIT. These units are part of over-all switchgear project. Attendant inspects cable entrance compartments. Note metal-enclosed bus overhead, potential transformers upper left, synchronizing reactors at lower left.

An outstanding example of

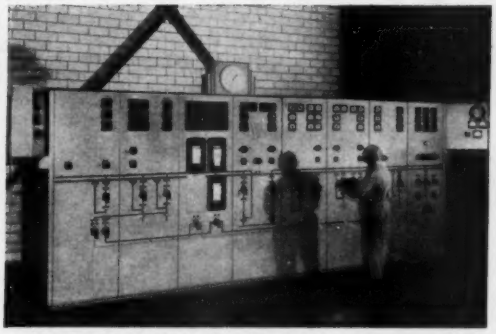
Project Planning

These General Electric, metal-enclosed equipments greatly simplify the planning of modern power stations. Installations may be made more compact. Complete enclosure in metal gives you greater safety and dependability.

Each of these metal-enclosed equipments is a completely co-ordinated unit—factory assembled and tested, shipped ready to install. Complete use of standardized G-E units permits an over-all co-ordination that may simplify your entire station design. For further information see your local G-E sales office or write to General Electric Company, Schenectady 5, New York.

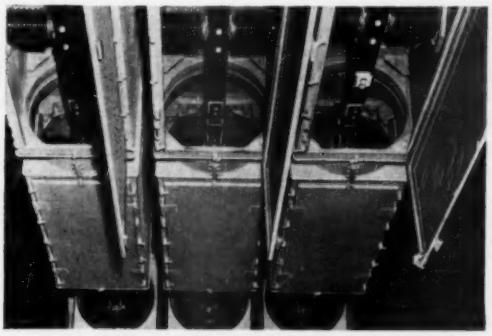
ordered and installed as one unit

METAL-CLAD EQUIPMENTS with Magne-blast circuit breakers for medium capacity circuits. Factory-assembled and completely coordinated, they include circuit breakers, buses, interconnections and interlocks—all in one compact package.



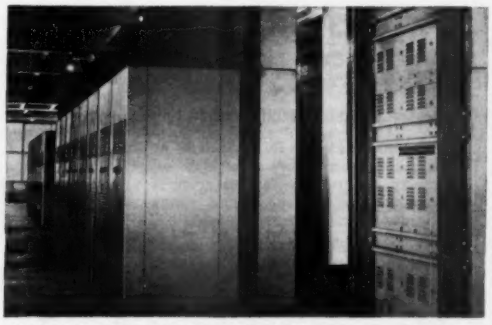
METAL-ENCLOSED DUPLEX SWITCHGEAR for centralized control and metering. These complete, factory-assembled units have control and indicating equipment on the front panels and recording, regulating and protective equipment on the rear.

METAL-ENCLOSED CABLE ENTRANCE COMPARTMENTS for the local power feeders. They include cable potheads and group-operated disconnect and grounding switches which permit easy isolation of the cable during maintenance.



METAL-ENCLOSED ISOLATED-PHASE BUS for all primary connections. Designed to withstand heavy-duty, high-capacity short-circuit stresses they are completely assembled and ready to install with other components.

METAL-ENCLOSED AIR-BLAST-CIRCUIT-BREAKER CUBICLES for main power circuits. Features included phase-segregation, mechanical interlocks, and silver contact surfaces. Available also with low-oil-content circuit breakers.



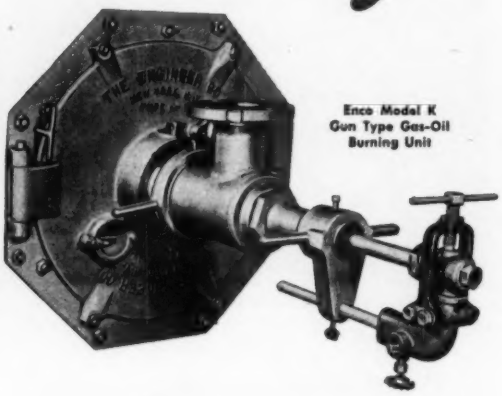
METAL-ENCLOSED REACTOR EQUIPMENTS factory-assembled with ventilated, grounded steel compartments—all ready to interconnect with metal-enclosed bus. Hinged doors provide easy accessibility for inspection and maintenance.

GENERAL ELECTRIC

855-27

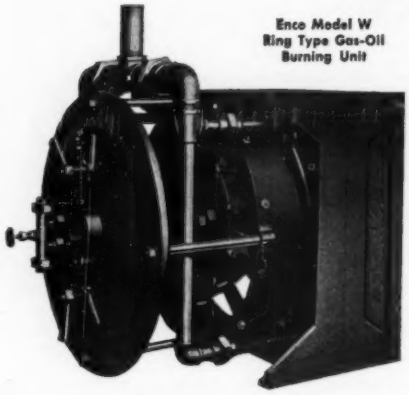
flexible... 3 ways

ENCO
OIL AND GAS BURNER UNITS



Enco Model K
Gun Type Gas-Oil
Burning Unit

These specially designed oil and gas burner units fit your needs . . . even when your operating conditions keep changing. Enco Oil and Gas Burner Units offer money-saving flexibility on three important counts. (1) They are designed for use with either oil or gas — or both . (2) They assure completely uniform combustion and greater fuel economy though steam demands swing sharply. (3) They can be operated by either natural or forced draft.



Enco Model W
Ring Type Gas-Oil
Burning Unit

Even if your old combustion equipment "works", it pays to investigate the fuel-saving economies and full flexibility of these highly efficient units. Enco Burner Units are made in many sizes to suit all capacity requirements. Bulletin on request.

ENCO
INTERCHANGEABLE ATOMIZERS
FOR USE WITH ALL TYPES OF BURNER EQUIPMENT

Wide Range Mechanical—Manual or automatic control. Constant high oil pressure at atomizer insures efficient atomization over entire load range without recirculating or returning oil.

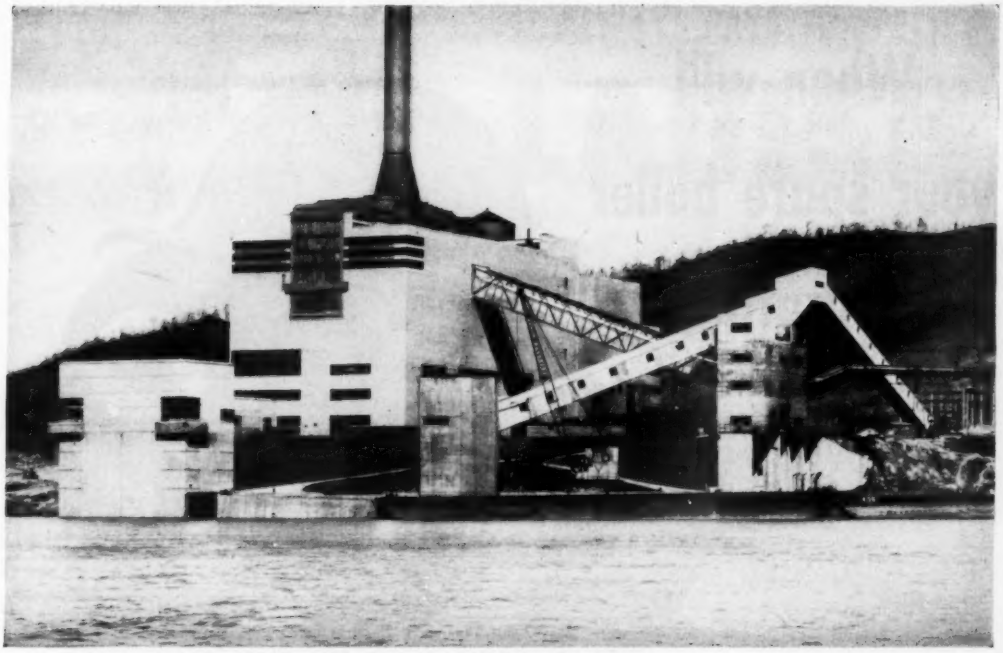
Steam or Air—Wide range. Controlled by manual or automatic pressure regulation.

Standard Range Mechanical — Available in all sizes to suit load and capacity requirements.

Enco Standard Range Mechanical Atomizer Gun
Enco Wide Range Steam Atomizer Gun
Enco Wide Range Mechanical Atomizer Gun
Enco Standard Atomizer Gun Support
Enco Gas Burning Gun

EC-493

THE ENGINEER COMPANY 75 WEST STREET, NEW YORK 6, NEW YORK
IN CANADA: F. J. BARRON, LTD., 4230 [illegible] ST., MONTREAL 34 P.Q.



Unique Circulating Water System Installed in This Power Plant

The R. E. Burger steam-electric plant of Ohio Edison Company is located on the Ohio River well above flood stage—which may reach as much as 60 feet above extreme low water. Water is supplied to the condensers by a patented circulating water system pioneered jointly by Worthington and the consulting engineer, Mr. George W. Saathoff.

All major equipment except circulating pumps, which are designed to operate completely submerged if necessary, are located above flood stage.

The new installation of a Worthington 70,000 sq ft two-pass condenser and auxiliaries, serving a 90,000 kw turbine-generator, is the third Worthington unit in this station. Two 46,000 sq ft condensers were previously installed.

For advice on any new installation or information on a wide range of power plant equipment, consult Worthington Pump and Machinery Corporation, Steam Power Division, Harrison, New Jersey.

HOW IT WORKS

Two full-capacity circulating pumps are used in series.* The primary pump, submerged below extreme low water, is a Worthington motor-driven HIFLO. Its high starting head characteristic is able to deliver enough water for starting purposes. A booster pump—a single-suction volute Worthington MIXFLO, mounted directly upon an hydraulic turbine—starts when there is enough water in the control well. The two pumps then operate automatically in series at full capacity.

Advantage is taken of maximum siphon effect from the condenser drop leg which enters the sealing or control well. From this well, all circulating water is passed through the hydraulic turbine. Thus the static head from sealing well to river level is utilized—75-80% being recovered—in reducing the work of the primary pump, with saving in overall pumping power.

The booster pump functions until rising water renders the turbine ineffective. Then the primary HIFLO works alone, producing full capacity under reduced head.

*In the new unit, there are two half-capacity primary pumps, permitting operation of only one in the winter when low water temperatures prevail.

Z.1.1

WORTHINGTON

WORLD'S BROADEST LINE OF STEAM POWER PLANT AUXILIARIES

Feed Water Heaters · Boiler Feed Pumps · Steam Turbines
Steam-Jet Ejectors · Water Treating Equipment · Surface Condensers

When will your spare boiler be drafted?

AS LONG AS the present international situation continues, defense production will be at a high level, and almost every plant may be called on to participate—which means that at any moment your 'spare' boiler may be needed in regular service.

Under these circumstances, unscheduled boiler outages mean *lost production*, at a time when production must be kept high.

Proper conditioning of boiler water is a major factor in boiler availability—and Hall Laboratories have been leaders in boiler water conditioning for more than a quarter of a century. They are prepared to recommend procedures which, in your specific situation, will give most desirable results at minimum investment and lowest operating costs.

Hall Laboratories are not, however, limited to boiler water conditioning. Hall also offers *plant-wide* water service, for every problem concerning the use of water in industry comes within the scope of Hall activities. May we send you a copy of the new Hall bulletin "Your Most Important Raw Material"?

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL *plant-wide* WATER SERVICE

BOILER WATER CONDITIONING

PROCUREMENT, TREATMENT, USAGE AND DISPOSAL OF INDUSTRIAL WATER

IT ALWAYS PAYS TO SPECIFY

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Controlled Quality

PIPE FITTINGS

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TO MARK PROGRESS

...you get full value for every fittings dollar

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

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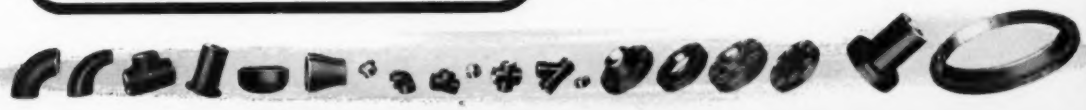
The more critically you appraise value... the more you will appreciate Ladish Controlled Quality Fittings. For the ultimate economy of Ladish Fittings is assured by laboratory, engineering and manufacturing controls unsurpassed for thoroughness and rigid standards. From metallurgy through machining ... repeated tests safeguard the extra strength and soundness vital to long dependable service ... extra value you can always depend on from Ladish Controlled Quality Fittings.



IT'S PACKED WITH SATISFACTION WHEN IT'S PACKED WITH R/M

The Raybestos-Manhattan packings in the stuffing box of this hydraulic accumulator ram play an important part in the machine's successful operation. The complete line of R/M packings and gaskets plays an important part in the successful operation of valves, compressors, pumps, hydraulic and other equipment of all types. The R/M distributor near you will gladly help select the right R/M packing or gasket to meet your needs. Or write for the new R/M Packing Catalog.

R/M PACKINGS

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn. Manheim, Pa.
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RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings · Asbestos Textiles · Mechanical Rubber Products · Abrasive and Diamond Wheels · Rubber Covered Equipment · Brake Linings · Brake Blocks · Clutch Facings · Fan Belts · Radiator Hose · Powdered Metal Products · Bowling Balls

NONPAREIL TRADE MARK **Turbine Oil**

For economy in the long run

IN the case of two 12,500-KW turbines serving a midwest utility, the "long run" already has covered fifteen years. During that period, the original fills of NONPAREIL Turbine Oil have maintained an acidity below .10 mg. KOH/gm., with never any need to remove the oil for treating or for cleaning of the turbine lubricating systems. That's lubrication economy!

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For economy in your own turbine lubrication, make your next fill NONPAREIL. Let a Standard Oil lubrication specialist show you the facts, including service records covering up to twenty-three years continuous operation of NONPAREIL Turbine Oil. Contact your nearest Standard Oil Company office. Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Ill.

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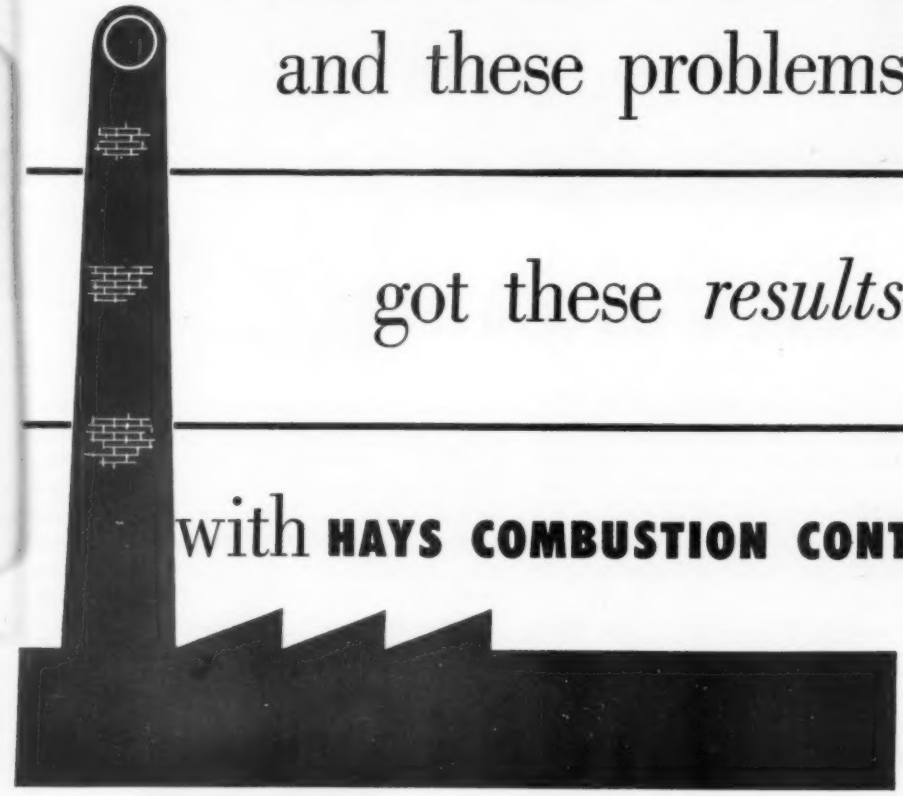
and these problems→

got these *results*→

with **HAYS COMBUSTION CONTROL**



	AMERICAN TOBACCO COMPANY	SHERWIN-WILLIAMS COMPANY	RAYBESTOS-MANHATTAN COMPANY	BEMIS BROS. BAG COMPANY	SUNSHINE BISCUIT COMPANY
no. of boilers	Three (one stand-by)	Three	Four	Two	One, plus steam generator incinerator
rating	16,500 lb per hr	65,000 lb per hr	19,650 lb per hr	70,000 lb per hr and 80,000 lb per hr	31,500 lb per hr
load	Varies from 40-50,000 lb per hr total fluctuation up to 20,000 lb per hr	75,000 max. each boiler	120,000 lb per hr in winter—70,000 lb per hr in summer	68,000 lb per hr in winter, 60,000 lb per hr in summer. Daily variation 15,000 lb per hr	From 10,000 to 30,000 lb per hr
fuel	Coal	Coal	Coal	Oil and coal	Oil
use of steam	Power and process	Process and space heating	Mostly for process, also for pumps, compressors and heating	Power, process and heating	Process
	1. To recondition or add new boiler 2. Better process load regulation	Combustion efficiency	To get better efficiency. To get more out of boilers due to rising load	Accurate control of pulverized coal and oil firing through wide load swings	To lower costs. Drastic load fluctuations
	(1) "The Hays instruments and controls, through greater efficiency . . . gave us the solution . . . that of increasing steam capacity" and (2) "regulating the steam that goes into process."	"Operating efficiency has been as high as 82%—much of the credit going to the accuracy of (Hays) automatically controlled combustion."	"Our basic reason for installing the Hays control was to obtain better efficiencies. Our aim was more than reached . . . efficiency . . . 79.3%."	"We have made test runs using the Hays automatic combustion control system, bringing the load rapidly up from 8,000 lb per hr to 80,000 lb per hr with excellent results."	"Our management and operating crew are well pleased with the new (Hays) unit, not only because of the low maintenance costs but also because the equipment enables us to keep close watch over our operating costs."

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Hays-Penn Flowmeters • Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages • Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

one **Infilco** *installation treats both boiler feedwater and pulp mill supply*

This modern 64,000 ton mill at Fernandina, Fla., using deep well water, successfully treats both boiler feed and process water with a 2.2 mgd Accelator® followed by Zeolite softening.

RAW WATER FROM WELLS	INFILCO-POLISHED
HIGH in dissolved minerals, alkalinity, magnesium and calcium hardness	ZERO hardness
APPRECIABLE iron and color	ZERO iron and color.
LARGE AMOUNT of silica present	LOW alkalinity and silica

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Coppus-Dennis FANMIX® Action

Jet reaction of steam-atomized oil is utilized in Coppus-Dennis FANMIX Oil Burners to rotate a fan which is an integral part of the burner. The air delivered by the fan is forced through a sheet of atomized oil, discharged from jets on a rotating disc. An ideal mixture for fast, complete combustion and peak efficiency is thus created.

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Thoroughly proved in important installations for more than two years, these unique burners have proved profitable investments wherever used. In one of its plants, the American Woolen Company equipped two 1000 hp boilers with six Coppus-Dennis FANMIX Oil Burners.

In Terre Haute, Indiana, Type DC FANMIX Oil Burners were installed early in 1948 on two fully automatic 250 hp steam generators in the Commercial Solvents Corporation plant. They were supplemented by a third FANMIX Oil Burner when another boiler was installed.

ONLY FANMIX OIL BURNERS GIVE YOU ALL 6 FEATURES

1. **INCREASED BOILER RATINGS.** All your furnace is used for combustion, none for mixing. You get higher unit heat releases.
2. **STEPPED UP FUEL EFFICIENCY.** Complete combustion guaranteed with 5% to 10% excess air.
3. **NO "HOT SPOTS."** Continuous explosion kills torch action and disperses heat uniformly throughout furnace.
4. **FORCED DRAFT EQUIPMENT ELIMINATED.** FANMIX action overcomes entire draft loss across burners. No blowers, duct work needed.
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6. **COKING OF ATOMIZERS REDUCED.** Tips air cooled by fan blades to point well below coking temperature. Less downtime, lower maintenance costs.

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IT WILL PAY YOU to learn the full details on why Coppus-Dennis FANMIX Oil Burners, made to Coppus "Blue Ribbon" standards of quality, promise superior performance. Send coupon today.

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Please send complete data on Coppus-Dennis FANMIX Oil Burners.

Name..... Title.....

Company.....

Address.....

City..... Zone..... State.....

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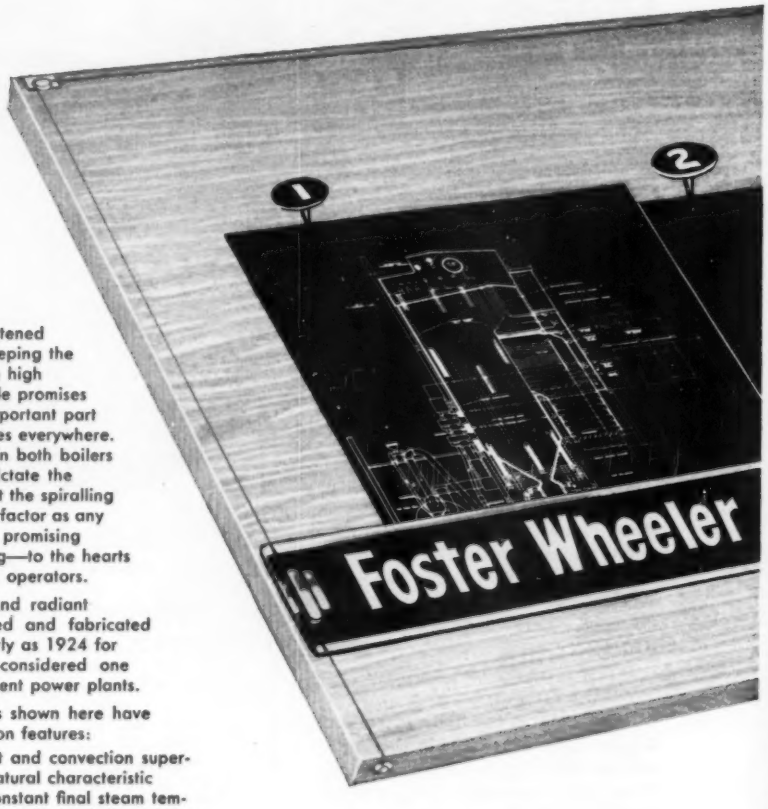

A new wave of enlightened interest in Reheat is sweeping the country as the role of the high pressure, high steam cycle promises to play an increasingly important part in power-generating facilities everywhere. Today, design developments in both boilers and turbines frequently dictate the use of the Reheat Cycle. But the spiralling cost of fuels is as much a factor as any in endearing this tool—so promising from its very beginning—to the hearts of steam-electric station operators.

Radiant superheaters and radiant reheaters were engineered and fabricated by Foster Wheeler as early as 1924 for one midwest station—considered one of the country's most efficient power plants.

The Foster Wheeler designs shown here have the following common features:

(a) Combination radiant and convection superheaters have a natural characteristic maintaining a constant final steam temperature over a wide load range with a minimum amount of control equipment.

(b) Since superheating is done partly in the radiant superheater a two-fold purpose is served. Gas temperature leaving the furnace can be reduced and danger of slagging is thus obviated.

(c) Steam generator characteristics are integrated with those of the turbine.

For further information, write to: **FOSTER WHEELER**

REHEAT— Four 700,000 lb per hr steam generators for an important midwest utility.

REHEAT—A 1,100,000 lb per hr steam generator for a large steam-electric station in central Pennsylvania.

REHEAT AND DUAL CIRCULATION—A 1,450,000 lb per hr reheat and dual circulation steam generator for a steam-electric plant in New York City. Dual Circulation, a Foster Wheeler development, makes possible the reduction of silica carryover to negligible quantities.

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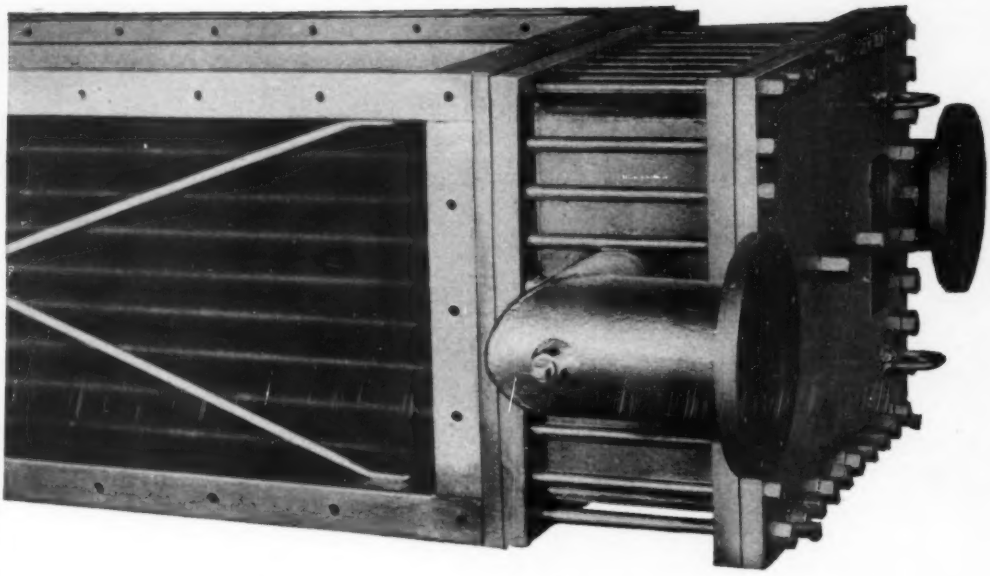
FOSTER WHEELER

TO COOL OR HEAT
AIR OR GAS
....EFFICIENTLY



G-R K-Fin Units are admirably suited for air and gas cooling and heating duties. The use of K-Fin Elements with mechanically bonded helical fins, requiring no tinning, enables these units to withstand high temperatures and to operate successfully on duties where loosening of fins cannot be tolerated.

One of the distinctive features of the G-R K-Fin Cooler is its cooling surface of superior effectiveness. The K-Fin elements of this unit have helical fins. These fins, forming an extended outside tube surface, provide a higher heat transfer rate for a given air or gas pressure drop than is obtainable with other finned tube coolers.

When used as a *generator air cooler*, the K-Fin unit is embodied in a self-contained, closed, dust-proof and fireproof system, using turbine condensate or other available water supply as the cooling medium.

Some of the many other applications of this unit are for recovering gases from solvents, dehydrating illuminating gas, cooling gases from annealing ovens, and other gas cooling services.

Write for Bulletin describing all the features of the K-Fin Air and Gas Cooler.

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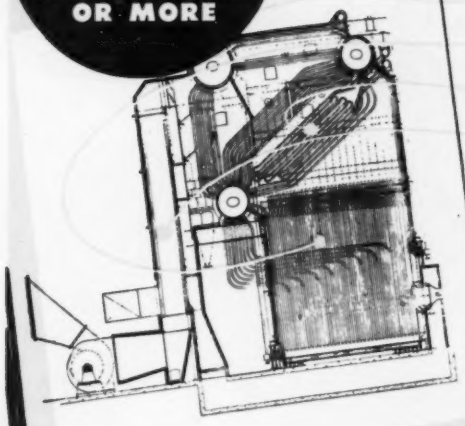
GRISCOM-RUSSELL

PIONEERS IN HEAT TRANSFER APPARATUS

IF YOUR
STEAM NEED
IS 50,000 lbs./hr.
OR MORE



Boilers
Water Walls
Superheaters
Air Preheaters
Economizers

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To meet the needs of those who require equipment to generate steam in large quantities, we have prepared a special book. In 40 pertinent information-packed pages on power plant equipment, we have described and illustrated design details and construction features of Erie City Boilers, Water Walls, Superheaters, Air Preheaters and Economizers. Users of large quantities of steam can find at a glance just what they need for new power plants, expansion programs and rehabilitation of existing facilities. The busy engineer or other executive interested in large capacity steam generating equipment will receive a prompt reply to his request for publication SB-30.

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ERIE CITY

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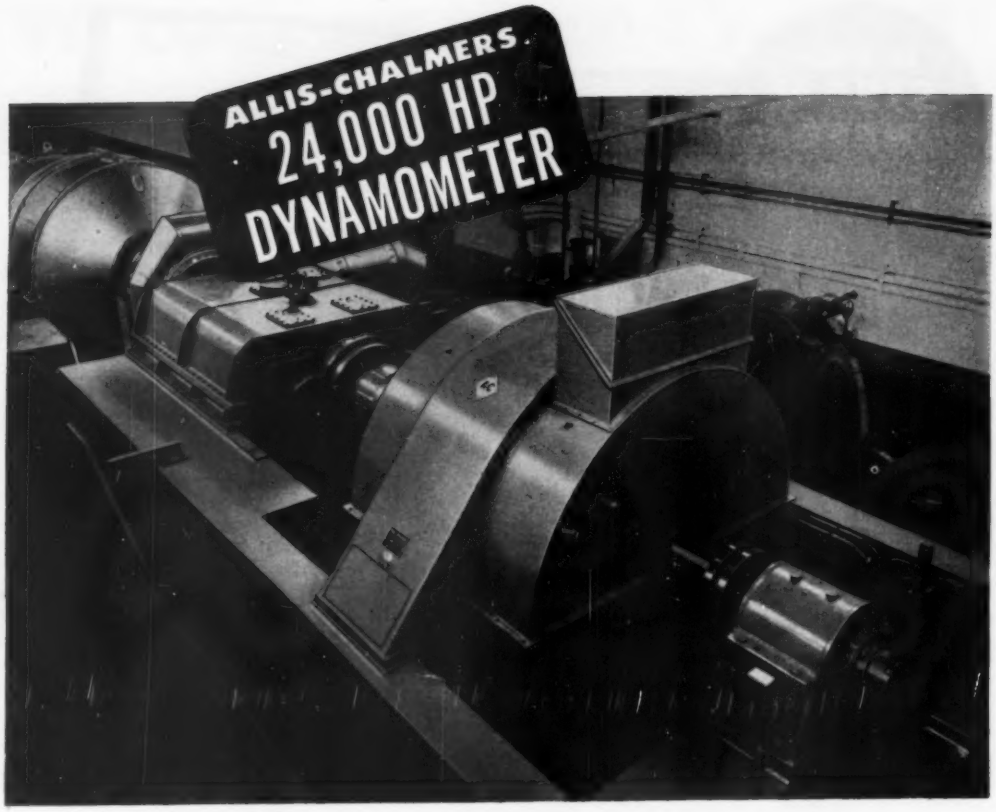
ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*



Another Example of Allis-Chalmers Engineering

DESIGNING AND BUILDING this special power-delivering dynamometer required engineering skill available only to a company such as Allis-Chalmers with its century of engineering experience.

Arranged for direct measurement of torque, the dynamometer has an accuracy of ½% of the rated torque. Its overall speed range is 1210 to 15,072 rpm. And the 24,000 hp synchronous motor and its speed-increasing gear are supported by a special hydrostatically mounted base. Although the assembly weighs 130,000 pounds, it is so well balanced and cradled that it can be moved by the pressure of a man's finger.

The dynamometer was built for the Pratt & Whitney Aircraft Division of United Aircraft Corporation for testing turbo-jet engines. Allis-Chalmers also supplied the torque measuring equipment, metal-enclosed bus duct and switchgear.

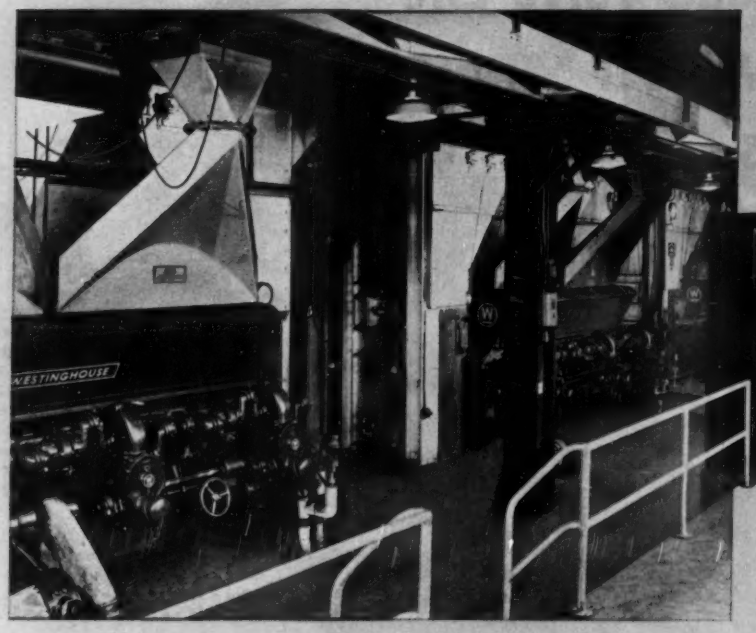
Whether you need special or standard equipment—for power generation, distribution or utilization — you can benefit from this engineering experience by calling your nearby A-C representative. Allis-Chalmers, Milwaukee 1, Wis.

A-3501

ALLIS-CHALMERS

YOU CAN BE **SURE**.. IF IT'S

Westinghouse



The chief engineer of the Bellefield Boiler Plant, Pittsburgh, Pa. checks instruments at panelboard in front of 3 Westinghouse Multiple-Retort Underfeed Stokers with Link-Grate. This modern, central heating station serves Carnegie Library and Museum, the Cathedral of Learning and the entire Pitt Campus, the Mellon Research Institute, the YMHA and four large hospitals.

14 YEARS' DEPENDABLE OPERATION...

MAINTENANCE COSTS only 1¾ cents per ton

Accurate records at the Bellefield Boiler Plant prove this outstanding economy story. Stoker maintenance costs for 14 years, totaled only $4,275 for 240,000 tons of coal consumed for an average cost of only 1¾ cents per ton of coal.

Maintenance economy like this is definitely a bonus beyond the exacting demands of continuous service . . . for RELIABILITY and CLEAN STACKS must be the prime consideration of plant management in serving a large group of public buildings. Only recently, another Westinghouse SDL Stoker was added to complete a battery of 3 Multiple-Retort Underfeed Stokers with Link-Grate that operate on a variable heating load of from 15,000 to 75,000 lbs. of steam per hour per boiler.

Westinghouse Stokers can give you these major operating advantages: Reliability, Flexibility, Lower Operating and Maintenance Costs. In addition you get the immediate attention of our Stoker Engineers for any of your heating, process, and power problems. Write today, Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-50519

Westinghouse STOKERS

For Features that Mean Long Valve Life and Low Cost Service Get this ALL-Purpose Edward Forged Steel Globe Valve

Edward Fig. 444-448 series, built in sizes ¼ to 2 in. inclusive . . . forged steel globe and angle . . . 600 and 1500 lb sp . . . bolted or union bonnet . . . screwed or socket welding ends . . . Fig. 448 illustrated.

CHECK THESE Big 1 FEATURES

- ✓ Hard bronze yoke bushing to prevent stem seizing or galling . . . lock welded to yoke
- ✓ Packing is Edward EValpak . . . heat resistant, water-proofed and die molded for long service
- ✓ Disk of EValloy 13% chromium or Stellite . . . slotted or disk nut type . . . self centering
- ✓ Tight, easily accessible bolted or union bonnet joint . . . with Ironkote gasket of 90 Brinnel max. hardness for leak-proof joint
- ✓ Heat treated forged steel inclined stem globe type body for lowest pressure loss
- ✓ Built-in pressure-tight backseat . . . permits repacking under pressure
- ✓ Roomy forged yoke . . . plenty of finger space for repacking
- ✓ Strong forged gland bolts . . . plated for long thread life

Edward Valves, Inc.
220 West 144th Street, East Chicago, Indiana

Please send literature covering your Fig. 444-8 series all-purpose forged steel valves.

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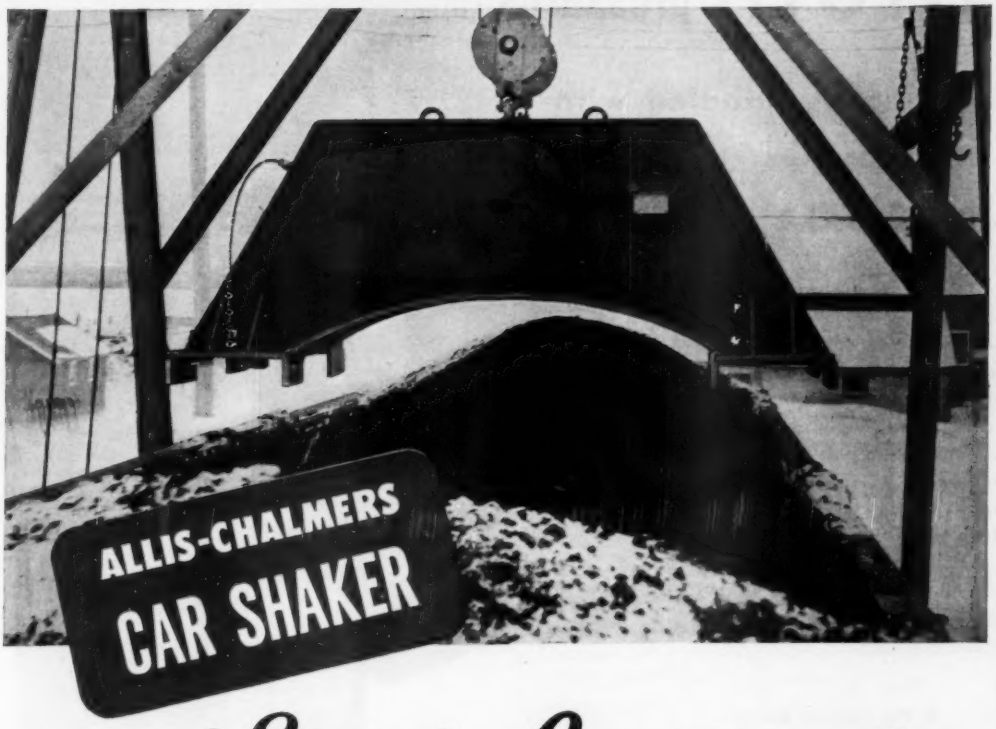

...and Sturdy Construction

BESIDES BIG SAVINGS in man-hours and demurrage costs, operators report savings in maintenance and downtime with Allis-Chalmers car shakers. And no wonder! Allis-Chalmers has designed these units for long, dependable service without trouble. For example:

- Shaker body is one-piece, all-welded structure made of 1 in. thick reinforced steel plate and stress-relieved to eliminate welding strains.
- Motor and drive are totally enclosed within shaker body, protected from weather and accidental injury. Motor is mounted in a special cradle base and protected from vibration damage with multiple shear mountings.
- Extra large bearing — 11⅞ in. outside diameter. Long bearing life! Heavy duty shaft arranged for hydraulic bearing removal.

Get more facts about how Allis-Chalmers car shakers can save money in your operations. Call the A-C representative in your area. Allis-Chalmers, Milwaukee 1, Wisconsin.

Car Shakers Promote Safety to Personnel!

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Allis-Chalmers Mfg. Co.
Milwaukee 1, Wis.

Please send my copy of Car Shaker Bulletin 07B7221A.

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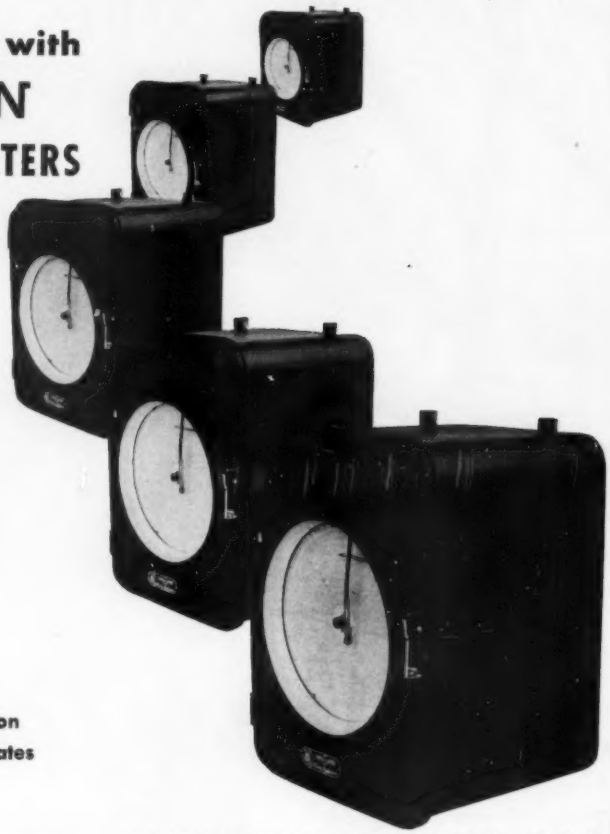
A-3468

HIGH differentials (up to 420" of water) pressures (up to 3,000 psi)

are easily handled with standard HAGAN RING BALANCE METERS



Hagan Ring Balance Meters are designed to measure high differential pressures, which are a source of difficulties in conventional meters.

Hagan meters, functioning under differentials of 420" of water, are housed in the same case as low-differential meters. No U-tube or drop leg is required.

Each Hagan Ring Balance Meter has all of these most important advantages, regardless of the static pressure.

- ★ No stuffing boxes
- ★ High torque-to-friction ratio
- ★ Ease of dead-weight calibration
- ★ High sensitivity at low flow rates
- ★ Adjustable full scale range
- ★ Mercury level not critical

For full details about Hagan Ring Balance Meters—a modern adaptation of the sound, simple radial torque principle which assures reliable results—just clip the coupon.

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RING BALANCE FLOW AND PRESSURE INSTRUMENTS
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Hagan Corporation
Hagan Building
Pittsburgh 30, Pennsylvania

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PE-10

At the BS&B factory . . . applying pressure until disc rupture occurs, to check actual rupture pressure against rated pressure of each disc.

Money Can't Buy A Complete Lot!

. . . because a generous, scientific sample of SAFETY HEAD discs is ruptured at the factory to assure you of precision pressure protection. This is only one of many checks developed through BS&B's long experience in the exclusive manufacture of these versatile overpressure relief devices. You can rely on SAFETY HEADS for instant, accurate action when needed!

No other relief device acts as quickly . . . full pipe-size opening afforded after disc rupture. If you have equipment under pressure, **you need SAFETY HEADS!**

Write today for free catalog, complete details. Ask about a free analysis of your pressure problem by a BS&B Engineer.

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for
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COMPLETE BOILER WATER TREATMENT

The Bendix-Westinghouse plant at Elyria, Ohio, is a show place of modern industry. Its facilities, from production machinery to power plant equipment, are new and modern—everything reflecting the company's slogan: "The Best Brake is Air—The Best Air Brake is Bendix-Westinghouse."

Modern boiler water treatment and corrosion control play an important part in this plant, too. The boilers, operating at 400 psi., are protected by Drew Complete Boiler Water Treatment. The steam and condensate return lines are protected by Drew Steam Line Corrosion Control. Better power plant operation is assured by the Drew 3-point program:

1. Drew engineers make thorough studies of boiler plant operations and water conditions.
2. Drew water chemists and engineers analyze this data in Drew laboratories and make specific recommendations for treatment.
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Thoroughness of investigation, proper treatment and frequent service have made Drew one of America's fastest growing water treatment companies. Industry's most respected names avail themselves of Drew Boiler Water Treatment and Service. Do the same. Consult the nearest Drew engineer or write for information.

Send for new illustrated DREW ORGANICS folder describing the use of organics in modern boiler water treatment. Write today.

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DREW PRODUCTS

Published by SCHUTTE and KOERTING Company

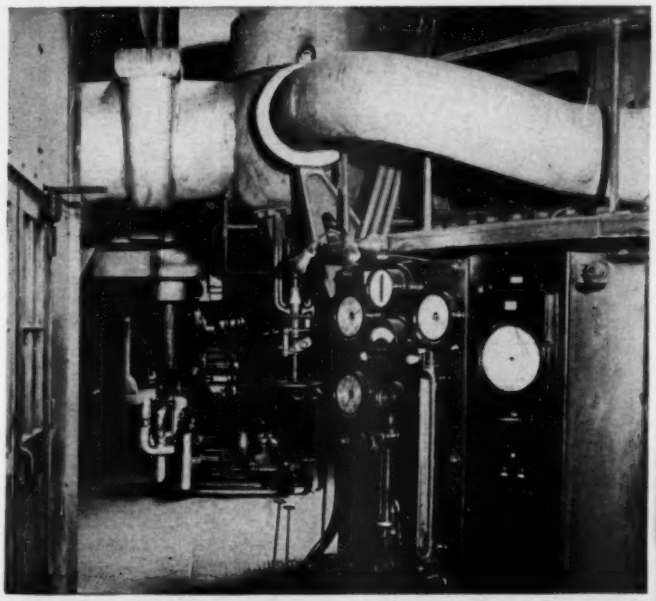
ENGINEERING News

SK HIGH PRESSURE VALVES FACE LIFE AT 40

FOR almost 40 years, three SK Inverted Turbine Throttle Valves have been performing efficiently with minimum maintenance at the Schuylkill Station of the Philadelphia Electric Company. They are still going strong. When the valves were installed, force for tripping was based on a differential area closing piston. Today, SK Valves of modern design are provided with springs for tripping.

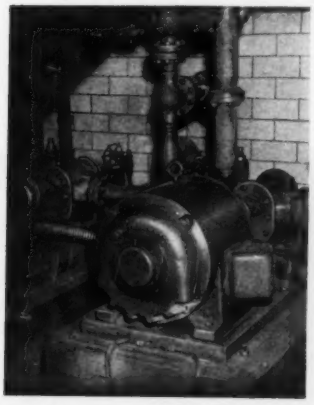
The particular valve shown in the close-up, one of the three, has a 14" inlet and two 10" outlets. It is located on the steam header to a 14,000 KW Turbine and passes 325,000 lbs. per hour of steam at 220 psi. Each of the three valves serves one turbine.

This long-life installation is typical of SK equipment. Over the years, we have accumulated a file of testimonials from SK customers satisfied with the efficiency and durability of SK Valves. We feel this justifies the SK policy that equipment, designed and built, not to meet a price, but to perform efficiently over a long period of time is the most economical in the long run. There are SK Valves to meet *your* needs. *Write for Bulletin* 8-D.



Efficiency and Economy Keynotes of SK Gear Pumps

Rugged pumping problems dictate soundly engineered pumps constructed of durable materials to insure long life and minimum



maintenance. SK Gear Pumps are just that! Take for example this New England power plant installation. The two pump sets pictured are each required to handle 40 gpm of No. 6 fuel oil at 860 rpm against 230 psi. Since the day they were installed, these pumps have built up an impressive continuing record for efficient and economical operation.

Built in any practical material, SK Gear Pumps will handle liquid free from solids in capacities up to 1000 gpm, and pressure to 3500 psi.

Schutte and Koerting Company maintain high standards of quality in all Gear Pumps by the strictest supervision of each step in the manufacturing process.

Whatever your pumping requirements, investigate SK Gear Pumps which are available from stock. Write for Bulletin 17-A.

SK ROTAMETER BULLETIN

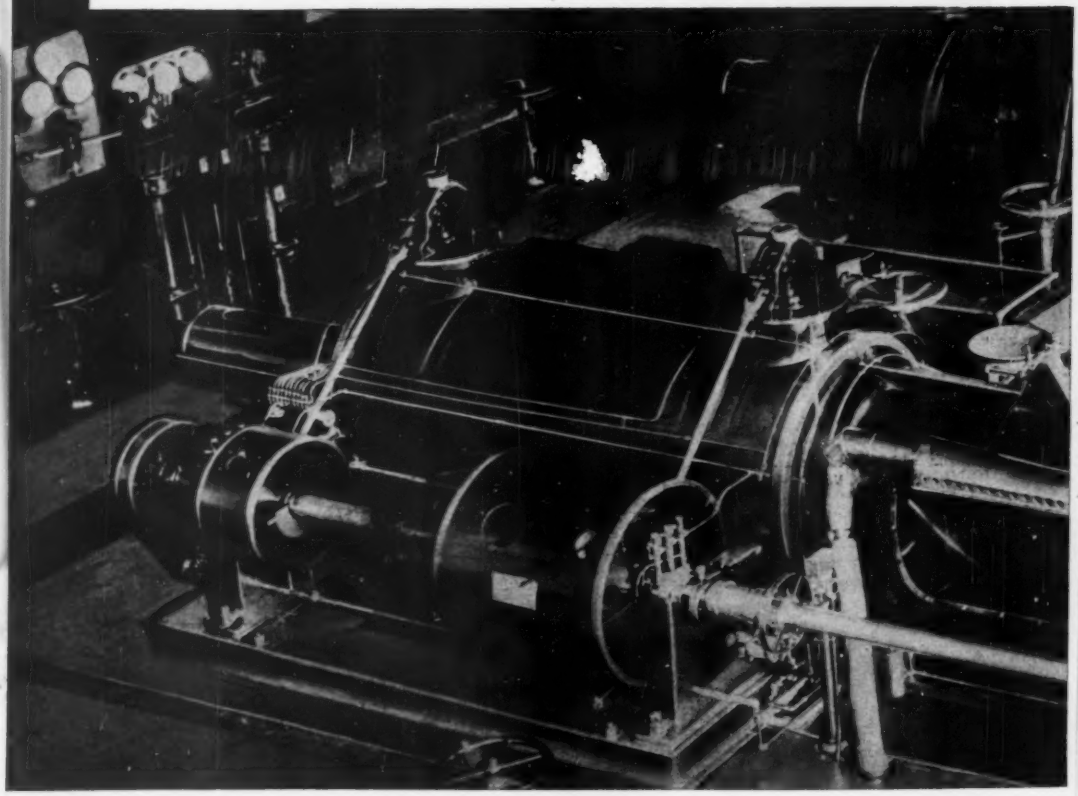
SK Bulletin 18-RA lists the various types and applications of SK Rotameters. *Request your copy.*

SCHUTTE and KOERTING Company

Manufacturing Engineers

For Extra Fine Lubrication..

use Sinclair Rubilene



Over many years engineers and plant operators have recognized Sinclair RUBILENE® as capable of rendering extra fine lubrication performance in the powerhouse.

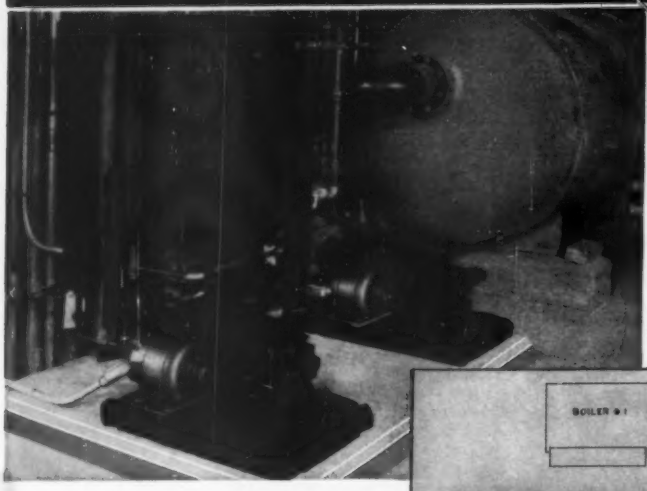
Sinclair RUBILENE has always been a top-quality oil, as it has been constantly improved through the years, incorporating the latest technological developments in refining and processing. It resists oxidation under continuous high temperatures, and re-circulation. It separates rapidly from water, and is non-foaming. Through long periods of use it retains its original qualities, providing uniform, trouble-free lubrication and low maintenance costs.

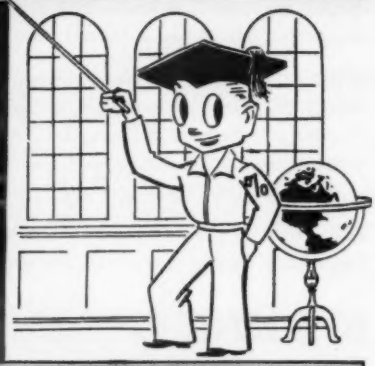
Yes... RUBILENE's finer quality pays dividends. For lubrication counsel, see your nearest Sinclair Representative or write direct to Sinclair Refining Co., 600 Fifth Ave., N.Y. 20, N.Y.

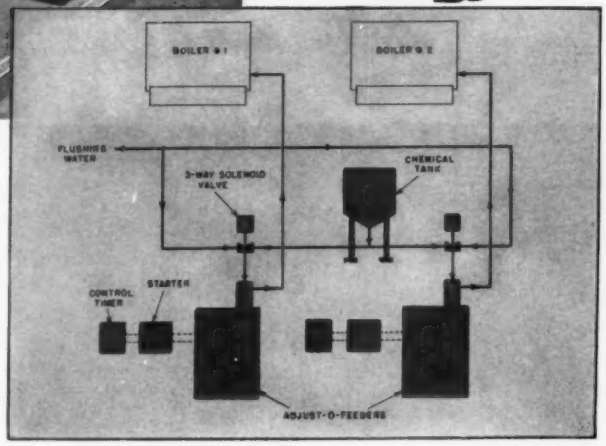
SINCLAIR RUBILENE®

for low maintenance costs

MAKE YOUR BOILER WATER CONDITIONING A ROUTINE OPERATION!







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System is Positive . . . Protecting Your Boiler and Reducing Steam Costs

All equipment shown red in photo and flowgram furnished by %Proportioneers, Inc.%

At Oberlin College this %Proportioneers% installation automatically provides correct boiler water treatment, adding the proper chemical in the correct proportion, at the right point, at the right time. Chemical treatment as applied by the %Proportioneers% system offers the advantages of improved heat transmission, fuel savings, and greatly reduced maintenance for every power plant from the largest high pressure installation to the smallest low pressure job. We supply complete chemical feeding systems including metering pumps, with control panels, chemical tanks, dissolvers and all other units required. Let us assume full responsibility for your complete chemical feeding system.

Write for Brochure SM9020 and Bulletin CAT.

No. 3 in a series on boiler water conditioning.

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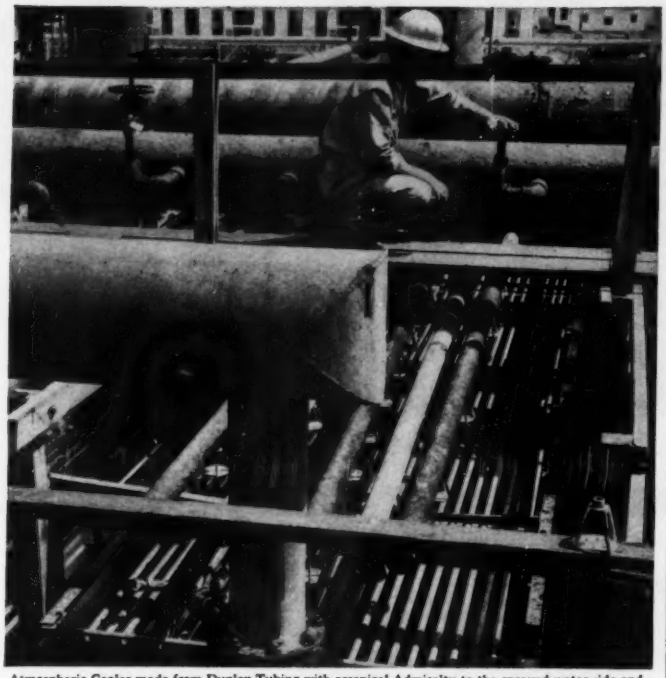
Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION

COPPER ALLOY BULLETIN

"Bridgeport" BRASS CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Duplex Tubing for Difficult Corrosion Problems



Atmospheric Cooler made from Duplex Tubing with arsenical Admiralty to the sprayed water side and stainless steel to the product side. Courtesy Celanese Corp. of America, Chemcel Plant, Bishop, Tex.

Frequently a relatively minor constituent may cause much more trouble than the medium itself. For example, pure water has practically no effect on stainless steel, yet water with a small amount of chlorides (a few parts per million) may lead to serious failures under certain conditions.

Atmospheric Cooler

An example of such failure occurred in an atmospheric cooler made from stainless steel tubing. Stress corrosion cracking took place on the outside of the tubing where it was subjected to a spray of fresh water containing a small amount of chlorides. The stainless steel stood up satisfactorily on the inside against acetic acid containing some formic acid.

Stress-corrosion cracking had developed from the water side and destroyed the usefulness of the tubing. However, by changing over to Duplex Tubing with arsenical Admiralty to the water side and stainless steel to the product side, the service life of the atmospheric cooler has been greatly increased. In addition, the heat transfer properties have also been substantially improved by the use of Duplex Tubing in its construction.

Stainless vs. Copper Alloys

The above illustrates the importance of studying the corrosion characteristics of each metal and applying the one best suited to withstand the particular corrosive media involved. It is recognized that in general, stainless steels are resistant to a large number of corrosive media. On the other hand, copper and its alloys possess excellent corrosion resistance to many gases, acids and salts and their water solutions. This explains their wide usage for handling cooling waters and other solutions that contain salts and gases.

Many users of stainless steel tubing have learned through experience what can and cannot be accomplished with stainless steel. Its fine performance in certain services has revealed that conservation of critical materials can often be achieved by using considerably thinner gauges.

Where one surface of the stainless steel tubing requires the corrosion resistance of copper and copper alloys towards cooling waters, brine, and certain chemicals, Duplex Tubing offers great possibilities.

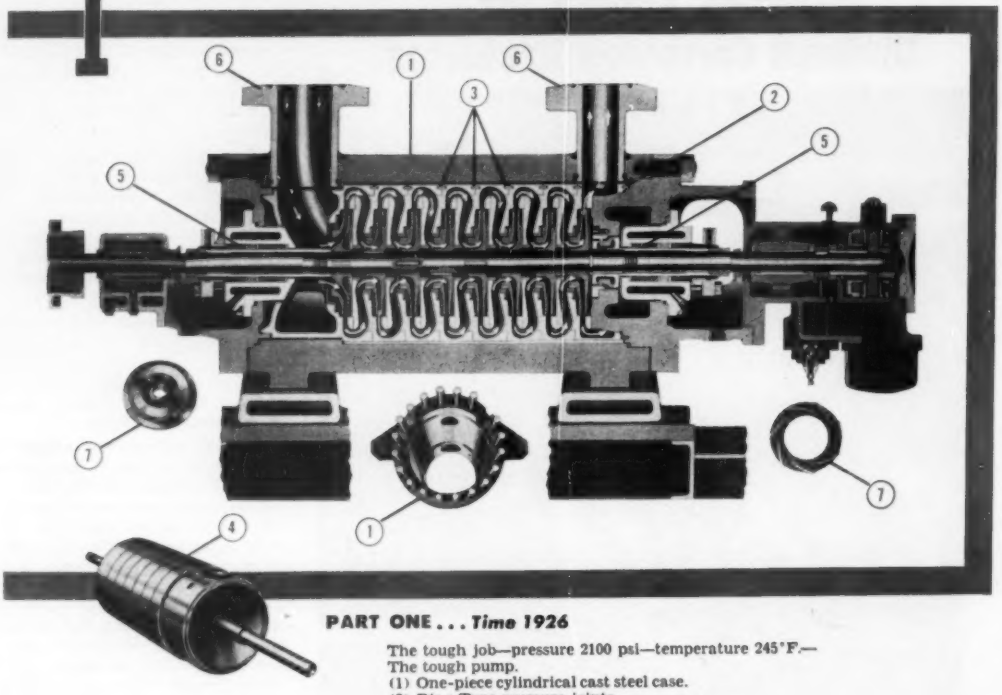
Stainless steel is outstandingly superior to copper towards impingement corrosion by steam and other gases but may be subject to attack on the water side. Thin stainless steel tubes lined with copper or a copper alloy offer a solution to this type of corrosion problem. At the same time, the fine heat transfer characteristics of copper are imparted to this Duplex tube combination. This means that heat exchangers and condensers, designed around straight copper tubes, can be retubed with copper lined stainless steel Duplex Tubing without any over-all loss in heat transfer rate.

Along the same lines, low chrome steels and stainless steels have in certain types of vent condensers and gas coolers given good performance except where the alloy is vulnerable to either stress corrosion cracking or pitting in certain types of fresh and sea waters.

Under conditions of low water velocity these ferrous alloys are quite susceptible to fouling by certain types of marine organisms in sea water. Biofouling may contribute toward rapid corrosion pitting and may cause a marked reduction in heat transfer rate. The use of a lining of copper or certain copper alloys assures considerable freedom from biofouling. For additional information on applications of Duplex Tubing, write for Bridgeport "Duplex Tubing Technical Bulletin No. 1950". (7216)

THE STORY OF TOUGH PUMPS FOR TOUGH JOBS

BY Pacific PUMPS, INC.



PART ONE . . . *Time 1926*

The tough job—pressure 2100 psi—temperature 245°F.—
The tough pump.
(1) One-piece cylindrical cast steel case.
(2) Ring Type pressure joints.
(3) Internal joints—metal-to-metal—no bolting.
(4) Unitized internal assembly—assembled outside case.
(5) Suction Pressure on both Stuffing Boxes.
(6) Suction and Discharge Nozzles on Heads.

PART TWO . . . *Time 1927*

The job gets tougher—temperatures rise to 850°F.—
The pump gets tougher.
(1) Cylindrical Case made from Steel Forging.
(7) Impellers, Diffusers and other parts of unitized assembly made from Chrome Alloy Steel.

PART THREE . . . *Time 1931-1951*

Refining a tough—without loss of toughness.
1931—(6) Suction and Discharge Nozzles made integral with case.
1932—(1) Line bore of case with Chrome Alloy by Fusion Welding.
1933-1951—Mechanical, hydraulic and metallurgical research and experience make a refined "Pacific Tough" available for the "Toughest Job".

PACIFIC *Precision Built* PUMPS

For Details—Bulletins 106 and 109

Pacific Pumps inc.

HUNTINGTON PARK, CALIFORNIA

Export Office: Chanin Bldg., 122 E. 42nd St., New York *Offices in All Principal Cities*

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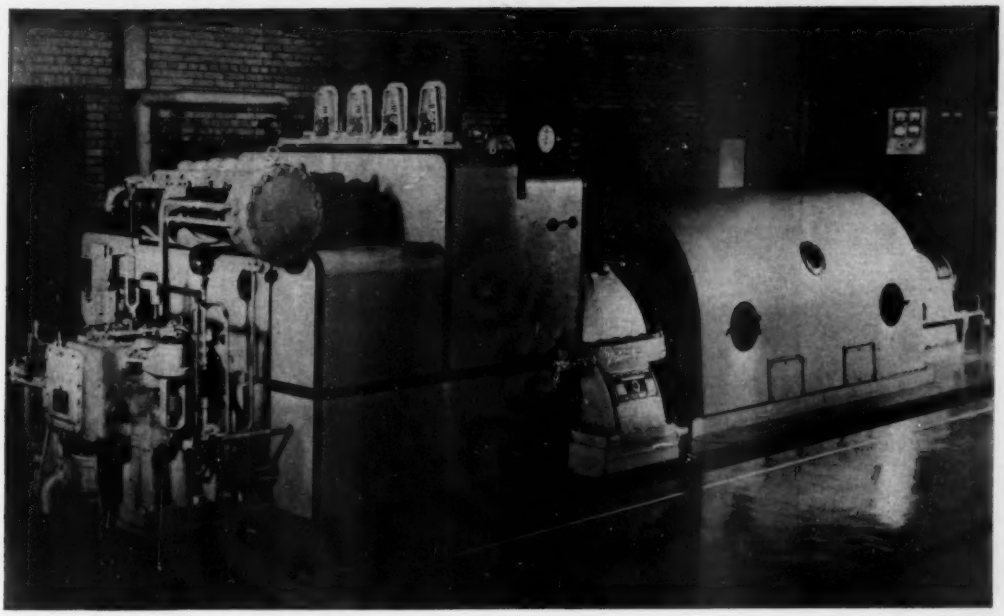


Story of an Economy Drive

How the Worthington Steam Turbine Pays Dividends for the City of Litchfield

What happened at Litchfield, Minnesota, is a clue to a most economical power plant operation.

Originally, the Litchfield municipal power plant consisted of low-pressure boilers, a steam engine and a small turbine-generator unit. The exhaust steam is sold for municipal heating.

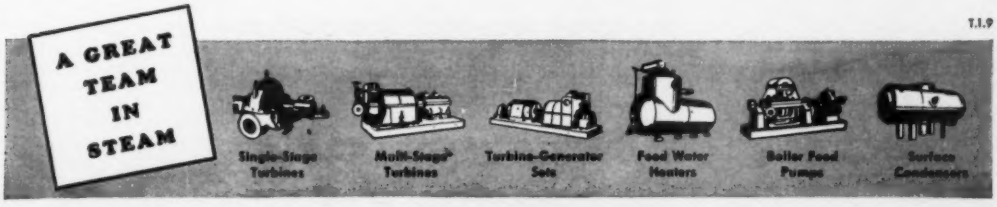
Next—a Diesel engine-driven generator was installed. The load grew, and finally, after a careful survey, it was decided to install a 3000-kw Worthington turbine generator and automatically extract steam for heating purposes.

Worthington builds steam turbines in all types and sizes—and turbine-generator sets up to 10,000-kw. For proof *there's more worth in Worthington*, call our nearest office or write to Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, New York.

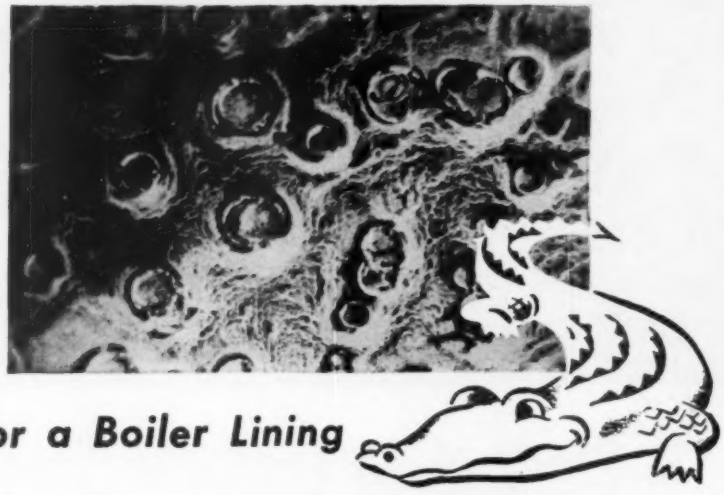
WORTHINGTON

STEAM TURBINE GENERATORS

T.I.9



Alligator Hide



for a Boiler Lining

THIS unusual form of calcium carbonate sludge could cause more trouble inside your boilers than a live alligator in the control room. That is why Nalco scientists deliberately cause scale and corrosion conditions in test boilers, then find the water treatment solutions for them — without subjecting Nalco System users to a "guinea-pig" role in testing new chemicals.

If your plant is not already enjoying the security of The Nalco System, ask for a no-cost water treatment survey, now. It may be the means of saving you real money on water treatment chemicals and plant maintenance.

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

INSTRUMENTS

101 Differential Converter — A mercuryless flow meter designed to feature fast speed of response for flow control and continuous range change adjustment from 0–20 to 0–200 in. of water, is introduced in illustrated Catalog 2281, 16 pp. Operating principles of this pneumatic-balance type flow transmitter are covered, as well as construction features, typical applications, detailed specifications and installation methods. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

102 For Determining Steam Consumption — Bulletin R-513 explains design, construction, installation and operation of manufacturer's rotary condensate meter, an economical means of determining steam consumption where all condensate can be captured. Includes size, dimension and weight table, simplified piping diagrams for both gravity and vacuum systems, also photos of installations, cutaway drawings of rotor operation. American District Steam Co., Inc.

103 SO_2 Analyzer-Recorder — Eight-pp Folder ND48-91 presents company's Thomas Autometer for automatic analysis and recording of air pollution by sulfur dioxide now available as either and integrating or non-integrating assembly with Speedomax electronic recorder. Principle of operation and application of the instrument is explained, illustrated. Schematic drawings show flow systems of both integrating type (which charts data in detail) and non-integrating type providing a simplified record. Leeds & Northrup Co.

104 Precision Gage Guide — A 50-pp ordering guide for manufacturer's line of thread and plain gages, Catalog 51 is well illustrated with photos and contains full information on sizes and prices as well as pertinent application suggestions. Includes a helpful section of tables and charts giving screw thread product limits, tolerances, basic dimensions, explaining measuring methods and illustrating standard thread gage forms. Republic Gage Co.

105 Imported Tachometer — Illustrated Bulletin 35-35 covers a multi-range, centrifugal type hand tachometer manufactured in Germany and now being distributed in this country after being unavailable for several years. Gives feature and operating details, price information. James G. Biddle Co.

106 Portable Anemometer — Two-pp Catalog 102 describes manufacturer's Air Meter for giving instantaneous direct readings of air velocities to 6000 fpm. Its applications, operation are discussed. Ranges, power characteristics and dimensions included. Hastings Instrument Co.

107 Wide Range Regulator — Featured in Bulletin 316 is an expansion stem type temperature regulator operated by water or compressed air. Explains how regulator works, how it is easily changed from direct-acting to reverse-acting instrument. Typical applications and available accessories pictured. The Powers Regulator Co.

108 For Lab Use — Illustrated Catalog D-185, 24 pp, introduces company's Dynoptic Labroscopes featuring ease of adjustment. Design improvements are explained and pictured. Three series of these microscopes are presented with specifications of most frequently ordered models, showing how by assembling various components, the exact instrument required can be had within budget limits. Price list included. Bausch & Lomb Optical Co.

ELECTRICAL, LIGHTING

109 Induction Motors — Construction features of manufacturer's large end-shield bearing squirrel-cage induction motors are described and pictured in Bulletin 05B 7642A. Built for a wide range of applications from central station auxiliary to general industrial drives, these motors come in ratings and speeds to 1750 hp at 1800 rpm, and bulletin points out possibilities of electrical modifications to suit application requirements. Allis-Chalmers Mfg. Co.

110 Packaged Electric Power — Bulletin GEA-5600, 24 pp, outlines methods of obtaining electric power equipment for quick expansion at low cost and with minimum of critical materials. Tells how "packaged" electrical systems simplify engineering problems. Illustrated with photos and diagrams, shows how "packaged" units comprised of standardized components, eliminate need for individually-engineered assembly of piecemeal components. Also lists 31 other publications on equipment for industrial power expansion. General Electric Co.

111 Easier Connectors — Catalog 49B provides 8 pp of illustrated data on the Eitherend electrical connector. Explains how two of these connectors in the same size can be used to make a quick, positive connection. Gives dimensional, price and general rating information, plus a summary of new uses. Albert & J. M. Anderson Mfg. Co.

112 Solenoid Contactors — Bulletin 4453 describes company's size O solenoid-type multi-pole contactors for load and control use in controllers for machine tools, refrigeration and air conditioning equipment. Discusses construction details, gives application information, ratings, dimensions. Ward Leonard Electric Co.

113 Power Factor Visualizer — A simple explanation of use of capacitors in solving low power factor problems is available in the form of a slide-rule-type chart, Form SA-5739. This visualizer makes it possible to follow a hypothetical case involving low power factor and shows how installation of capacitors can solve this and

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similar problems. Explains what low power factor is, what it means to both power user and supplier, and benefits to be obtained by improving power factor in industrial distribution systems. Westinghouse Electric Corp.

114 **Distribution Transformer** — Conservation features of company's Conservaire transformer which combines the wound type core with new insulation applications to provide a smaller unit with greater thermal capacity and improved voltage regulation are described and pictured in Bulletin 6137341. Includes dimensions for both conventional and self-protected types of oil-immersed, self-cooled, single-phase transformers. Allis-Chalmers Mfg. Co.

115 **For Pulp and Paper Mills** — Electric power system equipment for pump and paper mills is presented in 16-pp Publication GEA-5521. Illustrated with photos and diagrams, features discussion on types of turbine generators available and points to be considered in selection. Outlines company's power generation and distribution equipment designed for specific mill needs. Lists other bulletins concerning drives for specialized pulp and paper mill purposes from wet-end helper drives to multiple-generator drives. General Electric Co.

116 **Light for Safety and Security** — How good outdoor lighting can help prevent theft and sabotage, insure safe handling, reduce guards needed, provide greater safety for night shift workers and help solve their parking lot traffic problems, is told in Bulletin B-4731, 24 pp. An excellent presentation of plans, equipment recommendations and suggestions on applications and mounting methods, includes helpful discussion of power distribution and control systems. Covers lighting for various types of boundaries, piers and docks, entrances, storage yards and vital structures. Westinghouse Electric Corp.

MECHANICAL POWER TRANSMISSION

117 **Chain Drives and Conveyors** — "Installation, Operation and Maintenance of Chain Drives and Conveyors," is a 36-pp pocket-size text telling how to get the most service from sprocket chains. Explanations are brief, illustrations show right and wrong ways of solving chain problems. Booklet is published in theory that no chain will give complete satisfaction unless used properly and given periodical inspection, lubrication and adjustment. Tells how to assure longer life, low overall cost from sprocket chains. Includes check chart of "cures for sick chains." Chain Belt Co.

118 **Magnetic Drive Engineering Data** — Publication 1107 is a 32-pp booklet discussing precision speed control with adjustable-speed magnetic drive. Technical in scope, contains complete information both on the magnetic drive and company's new magnetic amplifier Regutron speed control. Data is clarified through the use of charts and diagrams. A fully illustrated section is also included covering industrial applications of the drive, control. Electric Machinery Mfg. Co.

119 **Worm Gear Drives in Action** — Illustrated and described in this 8-pp bulletin are some installations of this manufacturer's worm gear drive units. Among them are the Type CU built to take the punishment of cooling tower service, and a fan-cooled reducer suggested for use where space and weight are at a premium. The Cleveland Worm & Gear Co.

MATERIALS HANDLING

120 **For Coal and Bulk Materials** — Twelve-pp illustrated Form 512 describes a complete line of flight and belt type portable conveyors and under car unloaders for handling coal coke, sand, gravel and other bulk materials. Brief specifications are provided for both electric and gasoline powered models and hand-move and self-propelled conveyors. Lake Shore Engineering Co.

121 **Feeders, Conveyors** — An excellent presentation of electric vibrating feeders and conveyors is given in 90-pp Catalog 830 covering manufacturer's line of equipment for handling a wide variety of wet and dry materials and including large and small capacity units, for temperatures of —30 to 2000 F. Explains principles of design and operation, gives tips on installation, discusses controls. Includes photos, dimensions and specifications for models listed. Also provides many installation photos and information useful in planning for installations including a table showing densities of typical solid materials as they occur in handling operations. The Jeffrey Mfg. Co.

122 **Vibrating Screens** — Book 2377, 20 pp, presents vibrating screens for fast, dry-screening of light and fine materials, also liquid vibrating screens for low-cost, high-speed separation of solids from liquids. Includes specific information on selection of right screen and cloth for operating efficiency; dimension tables, weight and horsepower requirements. Link-Belt Co.

123 **Electric Car Pullers** — Catalog 100H-66, 8 pp, describes a complete line of electric car pullers, showing many uses for this versatile equipment. Stresses one-man operation of the pullers, shows how they can replace cumbersome and slow handling methods. Capstan, drum and continuous rope pullers are described along with specifications. Selection data and table of track curvature included. American Hoist & Derrick Co.

PUMPS

124 **Centrifugal Sump Pumps** — Eight-pp Bulletin WC-220 covers manufacturer's Type VS and VN sump pumps, wet or dry pit, for handling clear liquids, sewage and other liquids containing solids, and made in 1¼ to 8 in. sizes, capacities to 2000 gpm and heads to 120 ft. Besides helpful application suggestions, provides external and sectional views, impeller designs, dimensions, and selection tables. Warren Steam Pump Co., Inc.

125 **Big Pumps** — Illustrated Bulletin W-313-B1B is on company's Mixflo pumps for irrigation, drainage, sewage disposal, condenser circulating and low head water supply, and offering capacities from 8000 to 225,000 gpm at heads to 50 ft. Includes line drawings and dimensions of both vertical and horizontal types. Worthington Pump and Machinery Corp.

126 **Vertical Turbine Pumps** — Eight-pp Catalog 7228 describes company's Class APH-APK vertical turbine pumps, particularly applicable to bulk liquid transfer, cooling tower, dewatering or similar services where suction is taken from an open source. Tells advantages, explains construction features for both open, water-lubricated shaft or oil-lubricated enclosed shaft types. Ingersoll-Rand Co.

(Continued on page 180)

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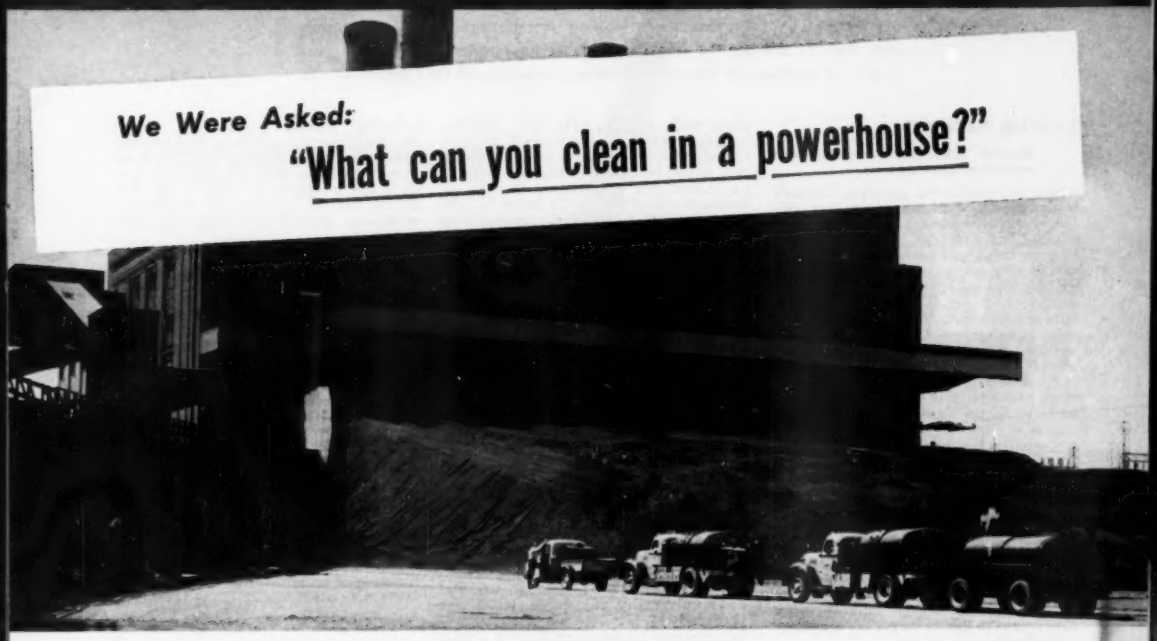

Here's Our Answer . . . *Proved by recent Dowell Jobs!*

There are many places in every industrial plant where Dowell Service can cut operating costs and *increase production time*. Wherever deposits on the surfaces of condensers, boilers, heat exchangers, water lines and other equipment are reducing capacity, Dowell Service can show money-saving results.

Dowell furnishes trained personnel and all necessary special equipment. Dowell engineers apply liquid solvents according to the technique demanded by the job: for example, by filling, spraying, jetting, cascading or vaporizing. The solvents are designed to remove deposits *quickly*, efficiently and economically. Dismantling is unnecessary and downtime is kept to a minimum. Often equipment can be cleaned while it is in operation.

Experienced Dowell engineers will be glad to consult with you on your particular problems. Call the nearest Dowell office today!

BOILER: A boiler was making only 12,000 lbs. of steam per ton of coal. After Dowell Service, the output increased to 18,000 lbs. of steam per ton of coal.

ECONOMIZER: A return-bend, integral economizer was cleaned by Dowell Service in 8 hours with no dismantling.

SUPER HEATER: Several tubes had blown out on a pendant type, non-drainable superheater because of heavy deposits. In just two working days Dowell Service did a complete job of removing these troublesome deposits.

TURBO SURFACE CONDENSER: An 800 KW Turbo Condenser was cleaned by Dowell. Result: The drop in steam rate demand represented an estimated yearly savings of $3600 in coal.

EVAPORATOR: Before cleaning, an evaporator operated at 24 lbs. per square inch steam and 11 inches of vacuum. After Dowell Service, it operated at 4 psi. steam and 13" vacuum.

HEAT EXCHANGER: Pressure drop on a heat exchanger was 52 lbs. with 150 gallons per minute flow. After Dowell Service, pressure drop was 22 lbs. with 200 g.p.m. flow.

BOILER FEED LINES: Before cleaning, it was necessary to use three 100 horsepower pumps to force water through clogged feedlines to the boiler house. Following Dowell Service, only one pump was required.

PUMP: Two high pressure feedwater pumps were nearly clogged with deposits. Dowell Service cleaned them along with the rest of the feedwater system.

TURBINE: Deposits on the rotor and stator of a turbine were removed quickly and efficiently by Dowell Service *in three hours.*

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NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the non-obligation, postage-paid card pages 37–38.

1—RING PACKING

Molded type, each ring is self-contained packing unit

A new automatic ring packing, Uneepac is designed for maximum sealing efficiency in minimum packing depth so stuffing box sizes can be reduced. Each ring centers itself perfectly on the preceding ring, company explains, and this reduces the chance of human error. In service, each lip is always exposed to fluid pressure and this provides instantly responsive sealing. Uneepac is offered in various compositions for water, steam oil, air, gas, vacuum, other services. It is furnished in sets of endless or split rings and available for shafts ⅜ in. dia and up. Johns-Manville.

2—CURRENT REGULATORS

Are oil-cooled, automatically controlled units of compact size

Constant current transformers of the new Subway Type CMH feature lighter weight, higher efficiency, and smaller size, manufacturer reports, because of their hypersil core construction, and, if necessary they can operate submerged in water. Their heavier tank construction is said to insure longer life and extra ruggedness.

These new regulators conform to EEI and NEMA standards and come in ratings from 3 to 30 kw with primary voltages of 2400 or 4800 and secondary currents of 6.6 or 20 amp at 60 cycles. Westinghouse Electric Corp.

3—FIRE DETECTOR

For new or existing installations, uses "rate compensation" principle

The Detect-A-Fire is designed to give an alarm the moment the surrounding air reaches the temperature for which the device is pre-set. Temperature settings to 325 F may be had, and areas as large as 625 sq ft can be protected by a single unit, manufacturer states.

The fixture fits snugly against the ceiling and is mounted in a curved steel case. Sensing element of the Detect-A-Fire is a stainless steel tube which is always in contact with the air. Hermetically sealed within this tube are silver electrical contacts and expansion of the tube with heating of the surrounding air brings the contacts together to sound an alarm or operate extinguishing equipment. Units are available for normally open or normally closed circuits. The device is designed to re-set itself after each alarm. Fenwal, Inc.

5—FLOOR COVERING

Is long wearing, designed to prevent slipping accidents

Fera-Mat provides a non-slip walking surface composed of durable mineral granules resin-bonded to a heavy-duty weatherproof cloth backing. It is supplied with a protective liner on the underside which is peeled off at the time of installation, and has a pressure sensitive adhesive which makes it adhere to any clean, dry and smooth surface. It comes in cleats 6½ by 24 in. or in rolls 6 ft wide by 96 ft long. Both are available in black; cleats also come in red and green.

This floor covering is suggested for steps, ramps, platforms, walkways and cat-walks, also entrances and corridors, storerooms, and wherever a non-slip surface is desired. Manufacturer says Fera-Mat is non-rigid, reasonably heavy loads can pass over it without damage, and maintenance is simple because dirt can be brushed out. American Abrasive Metals Co.

6—POWERFUL SPOTLIGHT

Is designed to provide 100,000 candlepower with 300-w rating

The Model 56 concentrates its entire light output in a long-throw, oval-shaped narrow floodlighting beam recommended for area protection lighting. It's made of non-corrosive, heavy-duty cast aluminum throughout, and has a universally adjustable swivel arm threaded ½ NPT to fit a variety of interchangeable accessories such as flat base, weatherproof junction boxes, wall brackets. Up to five units can be mounted to a single cluster light assembly — all lights in the cluster would have to go out before total darkness is possible. All wiring is enclosed. Stonco Electric Products Co.

7—GENERAL PURPOSE PUMPS

Are light in weight, easy to handle, install and mount

Said to be extremely adaptable, the Type SCC Centrifugal Pumps are suited for most small pump applications, including cooling towers, hot water heating systems, for booster and process pumping. Standard mounting of these close-coupled pumps is vertical, but with the addition of motor feet the pumps can be adapted for horizontal mounting. Motors are standard, open dry type.

Two sizes are available: 2 in. suction by 1¼ in. discharge, and 1½ in. by ¾ in. Both operate at 3450 rpm. Capacities range to 100 gpm, at heads to 120 ft. Cast iron construction is standard, but other materials can be had. Economy Pumps, Inc., Hamilton-Thomas Corp.

8—BASIC SWITCHES

High capacity, feature rigid lever actuation, low operating force

Demand for a high capacity basic switch requiring a lower operating force than that offered by flexible-leaf actuated switches has resulted in the addition of the new V Series to company's Type A Basic Switches. The rigid lever actuators are located in the same positions as those of the other precision snap-action switches in the Type A line and there is a choice of a long straight lever, a short lever with a roller and a long lever with a roller.

These switches are listed for ¾ hp, 115 v a-c; 1½ hp, 230 v, a-c; 20 amp 125, 250 or 460 v, a-c; 10 amp 125 v a-c "L" (suitable for controlling tungsten filament lamp loads on a-c circuits). Three types of terminals are available; solder lugs, integral screw terminals and side facing binder head screw terminals. Micro Switch.

9—THREAD RESTORER SET

Includes tools for re-chasing battered or damaged threads

Thread Restorer Set TR7 consists of eight sizes of restorers ranging from 1¼ in. bolt dia with 28 threads per inch,

4—LINE CLEARING TOOLS

Are air powered and insulated against electrical shock

These special insulated models of company's Limb-Loppers and other tools are designed to provide utmost safety against electrical hazards for line clearing crews. Single-piston and powerful double-piston models are now available. Standard lopper is 6 ft 8 in. long, weighs 9½ lb and has a cutting capacity of 1¼ to 1¾ in. The heavy duty model is over 7 ft long, weighs 11 lb 6 oz and cuts limbs up to 2½ in. dia. Extender units, 48 in. long, are also available. These pneumatic tools can be operated from a self-contained power source or power take-off compressor with capacities of 17 to 30 cfm, 125 to 150 psi. Miller-Robinson Co.

today piping repairs cost more!

Crane No. 465½
Iron Body Gate Valve

You make fewer of them by using Dependable Quality

CRANE VALVES

...That's why more Crane Valves are used than any other make

No bonnet joint trouble with this valve

A typical example of low-cost maintenance—Crane No. 465½ 125-Pound Iron Body Gates. Rarely does the bonnet joint need attention. Flange construction includes reinforcement to prevent distortion and utilizes more bolts, more closely spaced, than is usual in valves of this class. Crane precision-guided seating reduces seat and disc wear. Packing has long life because these valves have a deep stuffing box filled with high grade asbestos ring packing. A ball-type gland helps to equalize the packing load.

Better performance features like these make Crane the better buy in valves of every type. They assure low maintenance cost—low ultimate valve cost—for every piping service.

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to ¾ in. bolt dia with 16 threads per inch. Bonney Forge & Tool Works.

10—FILTERING UNIT

Removes water, oil, sludge, other materials from compressed air

The Model B Condensifilter combines in a single unit a dehydrating device, mechanical filter and self-purging trap. It measures 15 in. high and 9 in. dia and has a capacity of 30 cfm at 100 psi. It is suggested for purifying and dehydrating compressed air used in combustion and process control, in the operation of boilers, pneumatic tools, operation of agitation equipment, in blast furnace and open hearth control.

In operation, air enters through the side, goes through the condensing section where it is dehydrated and then through the mechanical filter. The condensing unit, which removes water in both entrained and vapor states, is a series of copper coils through which cold water flows. The filtering unit includes five hexagonal filter chambers in parallel, each wrapped in canton flannel, and easily removed for cleaning. When requirements are greater than rated capacity or when uninterrupted service is desired, Condensifilters may be installed in parallel. Hankinson Corp.

11—TEMPERATURE REGULATOR

Is expansion stem type, offers direct or reverse action

A modern version of this manufacturer's dependable temperature regulating instrument, the new Accritem is an expansion stem regulator used to maintain liquids or air at any desired temperature by controlling pneumatic or water operated diaphragm valves or dampers. It features simple, rugged construction and is intended for long service.

Temperature ranges of the Accritem are given as 50 to 250 and 150 to 350 F and it requires compressed air or water at 15 lb pressure. The sensitive element is an invar rod enclosed by a silver soldered copper bulb. No extra tools are required to change it from a direct-acting to reverse acting instrument, company states, and it's easily installed at point where temperature is to be controlled. It's suggested for use on instantaneous water heaters, heat exchangers, large water storage heaters, and for jacket water applications. The Powers Regulator Co.

12—SHOCK-RESISTANT ROPE

Is developed to protect linemen, maintenance and electrical workers

SeLectric Rope, now available, is a manila rope chemically treated and processed to "fight off water" and possess non-conductivity factors. Test results are reported to show that where it requires only 5 kv of voltage impressed on a 5 ft piece of untreated ½ in. rope, as much as 73 kv is required to force the same current through SeLectric Rope. South Eastern Cordage.

13—CURRENT TRANSFORMERS

Are butyl molded units for both indoor and outdoor use

Introduced earlier for indoor current transformers, the butyl-molding process is now being applied to a line of 600-v current transformers which can also be used outdoors, on single-phase and polyphase circuits. Company engineers say the main problems associated with use of butyl on outdoor transformers — water penetration, sealing of butyl to metal parts, and surface creepage — have been overcome. The butyl insulation combines low moisture absorption, good corona and sunlight resistance, good adhesion to copper, low power factor and resistance to mechanical damage. And by using butyl the more costly porcelain and metal cases are eliminated. The molded insulation also permits compact designs meeting standard dimensions for indoor applications and is waterproof for outdoor service.

First of the line is Type JKP-O a 600-v window type current transformer with primary ratings of 200-, 400- and 600 amp. It is designed to carry 200 per cent of rated primary current continuously. Meter and Instrument Dept., General Electric Co.

14—NOISELESS AIR VIBRATOR

Has "air-cushioned" piston action; offers variable speed, intensity

In the Type AC Vibrator the reciprocating action of a hard chrome-plated piston develops the vibrating action. This action is noiseless, company explains, because momentum set up by the piston is cushioned by a pocket of air at each end of the vibrator assembly.

The AC is described as ideal for use where vibrating equipment must be located near employees and is suggested for bunkers, bins and chutes for coal, powdered chemicals and similar materials to keep them from sticking, arching or rat-holing. The AC weighs 2 lb 11 oz., is 6½ in. long, 1½ in. wide. The Cleveland Vibrator Co.

15—BOMB RESISTANT WINDOW

Of glass plastic laminate, to minimize effects of explosive forces

Said to virtually eliminate dangers of flying glass in explosion areas, the Flexseal Bomb Window resists normal atmospheric pressures because of special design properties. When these are exceeded by a bomb blast or pressure wave the window is designed to open automatically by folding about its edges, and this action releases the pressure and keeps the frame from being blown in.

The window consists of three layers laminated into a single unit. The outer layer is a sheet of glass, the middle layer is a partially segmented sheet of polyvinyl butyral plastic, and the inner layer consists of four triangularly shaped pieces of glass, the central edges of which register with segmented edges of the plastic. The plastic layer extends beyond the glass edges and is bolted to the window frame to serve as hinges — letting the four segments open like doors when the outer plate glass is broken.

"Safety valve" of the window is the vinyl plastic, said to stretch up to 400 per cent of its unstressed length and return to ½ of one per cent without rupture. After an explosion of sufficient force to open the bomb window, the segments may be returned to position and retained there temporarily by adhesive tape, putty, or even chewing gum. Pittsburgh Plate Glass Co.

16—LIMIT SWITCH

For use wherever lightness, compactness and long life are required

As a direct-acting switch, the du.op has no inherent characteristics of bounce, according to manufacturer, and mechanical lost motion, which would delay contact operation, is eliminated because instantaneous contact is made at the same fixed point of repetitive plunger travel. The centrally-located plunger acts directly on the long contact spring to insure contact transfer with maximum spring pressure.

Contact arrangement is single pole, double throw, spring return and will handle up to 20 amp, 125 v a-c, noninductive. The du.op is enclosed in a phenolic-molded housing with same 1-in. mounting dimensions as snap-action switches. General Control Co.

17—MOBILE PURIFYING UNIT

For cleaning insulating oils in transformers and circuit breakers

Intended to eliminate power interruptions and breakdowns caused by contaminated insulating oils, the new Houdaille Purivac is designed to remove acidity, moisture and sludge and restore interfacial tension and dielectric strength of oil, all in one operation. It's automatic and described as a low cost method of reducing corrosion and deterioration of fabric insulation, preventing build-up of core moisture and prolonging the life of insulating oil.

Equipment consists of two purifiers, heat exchanger, dehydrating and degasifying unit, electrical control panel, pumps and motors, all mounted on a steel base. Flexible in operation, these units may be operated separately, in parallel or in series. Purification of insulating oil can be done in the field or at central station. Honan-Crane Corp.

18—ELECTRICAL INSULATION

Asbestos base, silicone treated, for high temperature use

Quinterra Type 3 is a Class H insulation (AIEE standards) for service at 180 C.

1/16-INCH "BREAKAWAY"... The *spring*-action of Flexitallic Gaskets simplifies the making and breaking of joints at valves or where there is close manifolding of piping. In raised face, smooth face, vanstone, lapped and ring joints only 1/16-inch "breakaway" distance is required. This *spring*-action is the direct result of the principle on which every Flexitallic Gasket is built: The spiral-winding of the V-crimped metal plies, alternating with plies of filler, produce a *spring* that is at highest efficiency when bolted up cold at required stud stress... Flexitallic Gaskets are engineered for operation at specified temperatures and specified pressures; to meet particular conditions of thermal or physical shock, corrosion, vibration, or unusual joint stress. For pressures from vacuum to 2500 lbs. For temperatures from -200° F to 1800° F... For all standard joint assemblies in four thicknesses—.125", .175", .250", .285"... For special joint assemblies up to 104" I. D.... Write us your requirements. Flexitallic Gasket Company, Eighth and Bailey Streets, Camden 2, New Jersey. Representatives in principal Cities. Consult your Classified Telephone Directory.

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PRESENTS

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"the Finishing Cement that Insulates"

IF IT'S TOO HOT TO TOUCH

IT NEEDS INSULATION

Powerhouse Cement is a star performer in the Baldwin-Hill line of insulating materials. Consider these advantages:

- Effective to 1700° F.
- One coat—points, seals, insulates
- No wire mesh . . . high adhesion to blocks, blankets, or plastic cement
- Finishes and insulates . . . figure its thickness as part of insulation
- Withstands drenching rain two hours after application
- Takes oil or water base paint direct

Powerhouse Cement is one of a complete line of B-H *Black* Rockwool insulating materials — block, blanket, cements, etc. A B-H representative will gladly show you how to reduce heat loss on the job — THERM-ENOMICALLY.

* *Economics of Engineered Heat Control*

Baldwin-Hill

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- ☐ Blankets—metal reinforced, large-area coverage to 1200° F.
- ☐ No. 1 Cement—plastic insulation, to 1000° F.
- ☐ Mono-Block—for temperatures to 1700° F.

BALDWIN-HILL CO., 907 BREUNIG AVE., TRENTON, N. J.

It is used for both inter-layer and wire wrapping insulation and is adaptable to a wide range of electrical devices including air cooled, inert gas, and silicone filled transformers. Advantages announced by manufacturer include savings on materials, greater factor of safety and opportunity for more compact design.

Quinterra Type 3 is supplied in sheets, rolls and tapes; widths vary from ¼ to 36 in. This insulation may be used alone or combined with other dielectric materials. Johns-Manville.

19—TRANSFORMER

Lighter-weight unit, is vapor-cooled and vapor-insulated

Now being developed is a vaporization-cooled transformer expected to be ¼ to ⅓ lighter than liquid immersed units of equivalent rating. The new cooling technique utilizes the heat of vaporization of liquid fluorocarbon vapor for cooling and the dielectric strength of fluorocarbon vapor for insulating. Vaporization-cooled transformers operated as experimental units are reported to show safety advantages, improved heat transfer, better utilization of temperature rise and extended voltage ratings.

Company engineers say a vaporization-cooled transformer will be as safe or safer than liquid-immersed or dry-type transformers because the fluorocarbon liquid is not only non-inflammable but has fire extinguishing properties. Superior heat transfer by vaporization permits a more compact coil assembly and reduced external cooling surface.

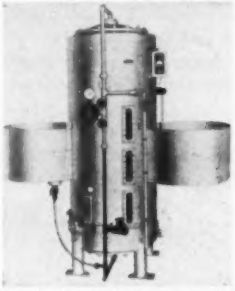
Because of the excellent heat transfer between coils and tank cooling surfaces it is considered possible to better utilize the temperature rise of the copper above the ambient; also cooler may be located at a distance, when desirable. And since the dielectric strength of the fluorocarbon vapor is superior to many gases, it believed possible to extend the voltage rating of the new transformers far beyond the present 15 kv ceiling for dry-type units.

Vapor-cooled transformers are expected to cost more than liquid-immersed types, company points out, but where their particular advantages are of importance, they may be an economical choice. Westinghouse Electric Corp.

20—DEMINERALIZING UNIT

Mono-bed type, available in flow rates up to 5000 gal per hour

This demineralizer operates on the mono-bed principle in which cation and strong base anion exchangers are intimately mixed in a single unit tank. Raw water passes through the mono-bed column only once, company explains, yet comes out with a mineral content of virtually zero. Penfield Mfg. Co., Inc.



21—INDICATING PAINTS

Are temperature sensitive; change color at predetermined level

Thermindex Paints, developed a few years ago, are again available in reasonable quantities, according to an announcement by manufacturer. They come in 16 basic colors, many of which show successive color transformation at several temperature levels. Applications for these indicating paints include the safeguarding of motors and other equipment against overheating, detection of faulty insulation of high pressure steam lines, determining efficiency of air-cooling arrangements. Tempil Corp.

23—ENCLOSED MOTORS

In 3 to 75 hp capacities, for explosion-proof requirements

The Types SE and SES Motors carry Underwriters' label for use in locations involving highly inflammable gases and volatile liquids, and for use in the presence of combustible dusts.

Features of the motors include sealed terminal, elongated spark-arresting bearing sleeves, high-draft ventilation, Lubriflush bearings, asbestos-protected windings. Being completely sealed, these motors also are protected against moisture, intrusion of abrasives, other substances. U. S. Electrical Motors, Inc.

24—LIGHT SOURCE

Is 400-w fluorescent mercury vapor lamp, for industrial use

The basically new J-H1 Lamp is designed to provide a whiter light from a mercury-vapor source. Its bulb has an inside coat of phosphor that flouresces red when activated by invisible ultraviolet light generated by the quartz arc. This tends to balance the spectrum to provide the whiter light.

The new lamp will burn in any position, company states, and can be used in existing fixtures for 400-w mercury lamps. Its bulb is of isothermal shape to provide an even operating temperature over the entire bulb wall. Lower brightness of the J-H1 makes operation at lower mounting heights practical, company adds, and increased fixture efficiency is had by removing the shield.

Electrically similar to company's A-H1 and E-H1 types the new J-H1 will operate from H-1 ballasts. For outdoor use, fixtures should be enclosed. Lamp Division, Westinghouse Electric Corp.

25—FLOORING MATERIAL

Is developed for longer service, resistance to heavy wheel traffic

The addition of pulverized natural rubber to a floor material consisting of asphalt-rock limestone and cold asphalt emulsion is credited with greatly increasing the life span of the floor, reducing brittleness in sub-freezing weather, providing greater traction when wet and lessening the tendency to rut under heavy point loads. Resistance to load impact and shock is said to be three times as great as for the same material without the rubber. As manufacturer says, there's a "Evenesa" about the installed floor which indicates its ability to "fight back" at traffic.

The flooring, named Immediate Set, is suitable for large area floor resurfacing with a relatively thin layer; and for patching small damaged areas: after rolling or tamping, it can be used immediately. Flash-Stone Co., Inc.

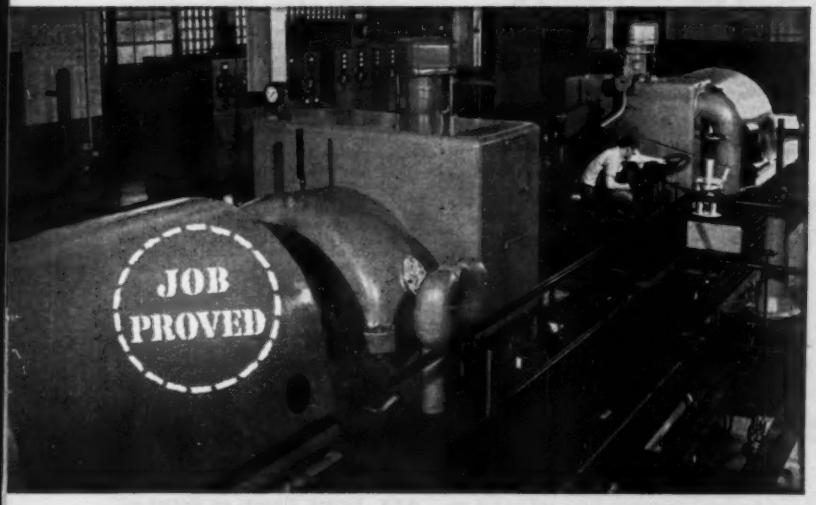
Chas. Pfizer & Co., Inc., is the discoverer and sole manufacturer of terramycin, the newest "wonder drug," which has proved effective in the treatment of *more than 50 acute infections.* Pfizer is the world's largest producer of antibiotics and a leading producer of synthetic Vitamin A.

Power—lots of it and never failing—is needed by Pfizer's modern plant at Groton, Conn., to safeguard round-the-clock production. The plant relies entirely upon its two steam turbines for power, light, and refrigeration. For the utmost protection, "Job Proved" Sunvis 916 Oil was chosen as the lubricant for these turbines when installed—two years ago. This Sunvis 916 has been in continuous service ever since. As expected, inspections show the turbines free from rust, sludge, and corrosion; and laboratory tests show the oil ready for thousands of hours of continued service.

Sunvis 900 Series Oils are unsurpassed as turbine lubricants. Under normal operating conditions they will be *good for the life of your turbines.* For complete information, telephone the Sun Office nearest to you or write Department P-6.

THE EQUIPMENT pictured here is utilized in one of the stages of a complex process that Chas. Pfizer & Co., Inc., world's largest producer of antibiotics, follows in the manufacture of its new "wonder drug," terramycin.

POWER FOR "WONDER DRUG" PRODUCTION PROTECTED BY SUNVIS TURBINE OIL



TWO 2,500 KW TURBINES, each charged with 300 gallons of Sunvis 916 Oil, generate all of the plant's power. The condensing-extraction unit has been running over 15,000 hours, the back-pressure unit over 7,000 hours.

THE LUBRICATING OIL flows continuously through a layer of wool, then a tank of water, and finally a triple bag filter. Recent tests at Sun's laboratories show that the oil is in excellent condition, and good for thousands of hours more.

SUN INDUSTRIAL PRODUCTS

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CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS AND AUXILIARIES

201 Steam Boilers — Form SG 128-749 is a 12 pp catalog illustrated with photos of steam boilers for processing and heating, ranging from 15 to 500 hp and 15 to 200 psi. Includes diagrammatic cross-section of four-pass design characteristic of manufacturer's boilers. Cleaver-Brooks Co.

202 Re-Circulation Steam Generator — Here's a 6-pp folder on a controlled re-circulation steam generator, describing its development and uses, such as applications where steam is required in remote locations, where demands are intermittent, or load fluctuating. Explains operation, features. Combustion Engineering-Superheater, Inc.

203 Packaged Generators — Bulletin SB-38 presents company's Keystone model. Photos and sketches show complete unit, pressure element and details of its compact design. Gives advantages of two-drum water boiler, three-pass gas travel, automatic gas or oil burner. Erie City Iron Works.

204 Shop-Assembled Boiler — Eight-pp Bulletin G-72 introduces company's new integral furnace boiler. Describes and illustrates its economy, ease of installation and connection, flexibility, minimum space requirements, efficient combustion, fast steaming. The Babcock and Wilcox Co.

205 Dowtherm Vaporizer — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer, tells how this unit is designed to evaporate Dowtherm to provide dependable operation at maximum temperatures. The Wickes Boiler Co.

206 Tube Expanders — Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators, other equipment. Thomas C. Wilson, Inc.

207 Rotary Tube Cleaners — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Roto_Div., Elliott Co.

208 Streamlined Baffle Walls — Bulletin BW-44, 20 pp, describes company's baffle walls, showing their application to modern boilers and for modernizing existing units. Fully illustrated with photos and drawings covering installations, remodeling designs. The Engineer Co.

209 Air Preheaters — Illustrated Bulletin A-11610, 8 pp, defines air preheat and explains its benefits in terms of increased efficiency and capacity and flame stability. Provides general description of company's preheater, discusses its application to boiler plants. The Air Preheater Corp.

210 Soot Blower Head — Illustrated Bulletin 485, describes a rotary soot blower head for improved boiler cleaning. Explains how head is designed to give maximum blowing pressure, is rugged, easily serviced, economical. Vulcan Soot Blower Div., Continental Foundry & Machine Co.

211 Double-Walled Tubing — Technical Bulletin 1950, 12 pp, presents tubing designed for conditions where single-walled tube can't withstand simultaneous attack from two types of corrosive media. Describes and illustrates construction, illustrating possible metal combinations. Explains tubing's use in ammonia refrigeration, boilers, steam generators and other applications. Discusses heat transfer properties, high temperature use. Also discusses prevention of galvanic corrosion. Bridgeport Brass Co.

212 Tube Expander — This 2-pp bulletin introduces a simplified tube rolling control for expanding condenser and heat exchanger tubing — a precision instrument for heavy duty service. Crane Packing Co.

WATER CONDITIONING

214 Water Conditioning Information — Here are three informational bulletins. No. 28X7446 describes a simple way to determine total hardness in water, illustrating procedure. No. 28X7559 gives an analysis of the hot process-hot zeolite system, telling results to be expected. No. 28X7466 discusses current status of embrittlement in boilers, explaining causes and telling recent developments in control methods. List bulletins wanted. Allis-Chalmers Mfg. Co.

215 Modern pH and Chlorine Control — This 100-pp booklet gives details of company's color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on meaning of pH control, electrometric and colorimetric methods of determining pH and impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

216 Water Softeners — Bulletin WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water, describes reasons for the popularity of the hot-process method, explains chemistry of hot-process water softening. Graver Water Conditioning Co.

217 One-Minute Water Tests — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50. Procedures, reagents, and equipment are described. Tells how tests determine water hardness, hardness due to calcium alone and hardness due to magnesium alone. Hall Laboratories, Inc.

218 Boiler Water Treatment — Bulletin 47, 8 pp, defines internal treatment of boiler water and tells its advantages in softening, sludge conditioning, stabilization. Explains company's system, including the chemicals used. National Aluminate Corp.

219 Ion Exchange Systems — "Amberlite Monobed Deionization" is a 12-pp miniature textbook covering history, performance, and potential uses of Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of various combinations of exchanges are explained. Also discussed are costs, quality of product, and rinse requirements. The Resinous Products Div., Rohm & Haas Co.

220 Chemical Treatment of Water — Bulletins describing various methods of chemical water treatment, including company's Coravol process, are available. Coravol is part of a complete technical service which provides special chemical formulas for boiler feed water, foam prevention, hot water supply, refrigerating brine, cooling and condenser water. Western Chemical Co.

221 Boiler Water Manual — Factual information on methods of applying chemicals in treatment of water for boilers is presented in 16-pp Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feed-water system, condensate returns, flushing. % Proportioneers, Inc.%

222 Water Softening Equipment — How problems caused by hard water can be offset by water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. The Permutit Co.

223 Water Treatment — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blowdown adjustment, test control. Describes available equipment and includes reference bibliography of literature on specific formulations. Dearborn Chemical Co.

224 Boiler Corrosion — A 12-pp article discussing cause and prevention of corrosion in boiler systems is presented in Bets Technical Paper No. 111. The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity, physical factors are evaluated. W. H. & L. D. Bets.

225 Zeolite Water Softeners — Publication 4530, 16 pp, presents hydrogen zeolite (cation exchange) water softening equipment. Gives complete description of the process and the field of application, showing advantage of hydrogen zeolite softening and its relation to sodium zeolite softening process. Cochrane Corp.

226 Corrosion Treatment — "Corrosion Protection of Steam and Condensate Return Systems" is a folder on amine treatment for boiler and condensate systems. This treatment is described as affording surface protection of the metal as well as raising pH value of condensate. The Bird-Archer Co.

227 Slurry Type Softener — Six-pp Bulletin W-212-B6 describes a slurry type precipitating softener and coagulator in which energy for floc preparation is mechanical, explaining and illustrating flow circuit. Question-and-answer appraisal of system. Worthington Pump and Machinery Corp.

228 Organics in Water Treatment — Here's a folder describing need for organics in altering nature of sludge to make it non-adherent. Covers theoretical and practical considerations involved in use of organics; tells how they overcome problems of sludge. Power Chemicals Div., E. F. Drew & Co., Inc.

ELECTRICAL

230 Power Factor Correction — Examples showing basic considerations in the improvement of system power factor are contained in Bulletin O5B7465. Points out advantages of improving plant power factor and advisability of keeping load power factor up to 0.8 lagging or higher; tells how the effects of low power factor can be corrected. Allis-Chalmers Mfg. Co.

231 Synchronous Motors — High speed synchronous motors are described in Bulletin PB 5600-1. Includes descriptive matter, photos showing features. Elliott Co.

232 Care of A-C Rotating Equipment — To promote intelligent and consistent maintenance of electrical machines, company offers Bulletin O5R7417, a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, drying moist insulation, measuring insulation resistance. Allis-Chalmers Mfg. Co.

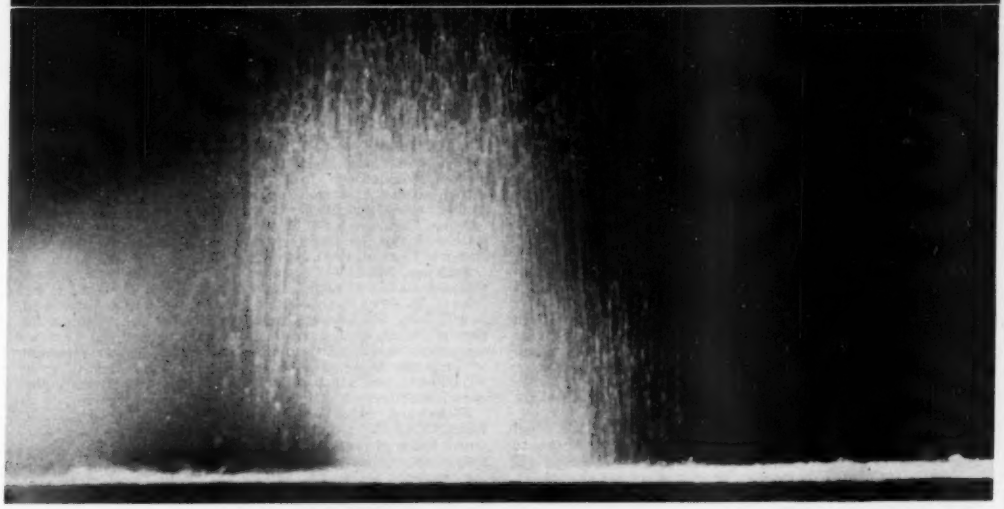
233 Buyers' Manual on Motors and Control — Fifty-pp Catalog GEC-1009 presents buying information on a carefully selected group of motors, motor starters, control accessories and electronic control. Ratings listed are those most frequently required. Excellent data on proper selection is provided. Illustrated. General Electric Co.

234 Co-ordinated Protection of Motors — The interlinked protection of circuits, motors and personnel is explained

(Continued on page 158)

this is **aerosolitis**

(pronounced: air-o-sol-ité-is)



Dearborn improved polyamide anti-foams will

prevent this boiler disease

Tiny drops of water dispersed in the steam—called *aerosols*—cause superheater deposits, foul turbine blades. When this happens, your boilers have aerosolitis, and costly shutdowns and repairs will result.

Preventing this boiler disease, which is more prevalent with some waters than with others, can be easily and inexpensively accomplished with Dearborn Improved Polyamide Anti-Foams which inhibit aerosol formation. In addition to this vital function, Dearborn Polyamide Anti-Foams prevent foaming to produce purer steam . . . eliminate scale formations . . . condition sludge . . . are compatible with other treatment.

If you produce steam for power or process use, investigate the benefits of Dearborn Improved Polyamide Anti-Foams.

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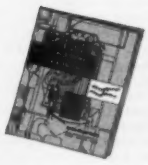

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Informative bulletins are available on (1) Dearborn Improved Polyamide Anti-Foams, and (2) Dearborn Industrial Water Treatment and Engineering Service. The coupon is for your convenience.

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POWER PLANT Construction News

Little Rock, Ark. — Hankins Container Co., 3044 West 106th St., Cleveland, Ohio, corrugated boxes and containers, plans boiler house at proposed new converting plant at Little Rock, where site has been acquired. Entire project reported to cost close to $250,000. Work will begin at early date.

Ozark, Ark. — Arkansas Valley Electric Cooperative Corp., Fayetteville, Ark., is having plans prepared by Burns & McDonnell Engineering Co., 95th St. and Troost Ave., Kansas City, Mo., consulting engineer, for proposed new steam-electric power plant near Ozark, previously noted in these columns. Entire project will cost about $10,500,000, including transmission and distribution lines, and other operating facilities. Financing has been arranged through Federal aid. Proposed to begin work this fall.

Los Angeles, Calif. — Bd. of Water & Power Commissioners, 311 South Spring St., has authorized a power revenue bond issue of $17,000,000, proceeds to be used for extensions and improvements in power plants and system, and for beginning work on new steam-electric generating plant in San Fernando Valley district. Total ultimate cost of latter project is estimated at $58,000,000.

Merced, Calif. — Filice & Perrelli Canning Co., South 10th St. and Hall Ave., Richmond, Calif., canner and packer of fruits and vegetables, plans boiler plant at proposed new processing and canning factory at Merced. It will consist of a main one-story building for general production and several smaller units. Entire program is estimated to cost close to $1,000,000. M. D. Perkins, 110 Sutter St., San Francisco, is engineer.

Hartford, Conn. — Hartford Electric Light Co., 266 Pearl St., has placed order for structural steel framing for addition to local steam-electric generating plant. Additional equipment will be installed for increased capacity. No estimate of cost announced. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

Stamford, Conn. — Connecticut Light & Power Co., 36 Pearl St., Hartford, Conn., plans new steam-electric power plant in Cove district, Stamford. Application has been made to local zoning board for permission. No estimate of cost announced. Details will be determined soon.

Panama City, Fla. — Arizona Chemical Co., 30 Rockefeller Plaza, New York, N. Y., industrial chemicals, plans boiler house at proposed new naval stores plant at Panama City, primarily for production of turpentine. Project has been approved by National Production Authority and work will begin soon. Cost estimated about $900,000.

Brunswick, Ga. — Hercules Powder Co., Brunswick, industrial chemicals, naval stores, cellulose products, etc., has authorized plans for addition to boiler house at local plant, estimated to cost about $180,000, with boiler units and auxiliary equipment. Project has been approved by National Production Authority and work will be carried out soon. Main offices are in Delaware Trust Bldg., Wilmington, Del.

Rome, Ga. — Georgia Power Co., Atlanta, plans new steam-electric generating station near Rome, where tract of about 350 acres of land has been purchased, fronting on Coosa River. Station will be equipped for a rating of 200,000-kw., divided into a number of turbine-generators, high-pressure boilers and auxiliary operating units, and is estimated to cost about $20,000,000. Proposed to begin work in near future.

Boise, Idaho — Idaho Power Co., Boise, is arranging financing in amount of about $18,000,000, through sale of bonds and other securities, portion of proceeds to be used for expansion and improvements in plants and system, including work now in progress.

Des Moines, Iowa — Solar Aircraft Co., 18th and Grand Sts., Des Moines, airplane engine equipment, jet engines and parts, plans boiler house at new plant in vicinity of Fleur Dr., Bell Ave., and line of Great Western R.R., where tract of land has been secured. It will be one-story, 450 x 650 ft. Cost about $1,600,000. Completion is scheduled next spring. Main offices of company are at 2200 Pacific Hy., San Diego, Calif.

Eddyville, Iowa — Iowa Southern Utilities Co., Centerville, Iowa, has awarded contract for steel frame superstructure for new steam-electric generating station at Eddyville, recently referred to in these columns, and work will begin this fall. Plant is estimated to cost about $7,500,000. Pioneer Service & Engineering Co., 231 South LaSalle St., Chicago, Ill., is consulting engineer.

New Orleans, La. — Edwin H. Fitler Co., 5625 Tacony Ave., Philadelphia, Pa., cordage, rope, twine, etc., plans boiler house at new mill at New Orleans, where tract of waterfront property has been secured under long-term lease with Port Commission. It will comprise a main building and several auxiliary structures. Entire project estimated to cost close to $1,000,000.

Hawkins Point, Md. — Consolidated Gas, Electric Light & Power Co., Lexington Bldg., Baltimore, Md., plans new steam-electric generating station at Hawkins Point, where tract of about 100 acres of land is being acquired, fronting on Patapsco River. Installation will include a 100,000-kw. turbine-generator, high-pressure boilers and auxiliary equipment. Cost reported close to $20,000,000, with switchyard, power substations, transmission lines and other operating facilities. Proposed to have plant ready for service in 1955.

Braintree, Mass. — Electric Light Dept., 44 Allen St., has plans under way for extensions and improvements in municipal steam-electric generating station, with installation of equipment for increased capacity. Cost estimated about $1,500,000. Charles T. Main, Inc., 80 Federal St., Boston, Mass., is consulting engineer.

Alma, Mich. — Leonard Refineries, Inc., Alma, plans extensions in power plant, with installation of additional equipment for increased capacity. Work will be carried out in connection with a general expansion program at oil refinery, designed to double present output of refined petroleum products, including gasoline. Cost about $3,100,000. Program will require approximately 18 mos. for completion. Approval has been granted by National Production Authority.

Jackson, Mich. — Consumers Power Co., Jackson, has authorized plans for further expansion in Justin R. Whiting and John C. Weadock steam-electric generating stations. First noted, near Toledo, will advance output by 106,000-kw., with installation of turbine-generators, high-pressure boilers and auxiliary equipment, scheduled for completion in 1953; other expansion will increase capacity of Weadock plant, near Bay City, by 135,000-kw., and will be completed in 1954, with similar equipment installation.

Vicksburg, Miss. — Spencer Chemical Co., Dwight Bldg., Kansas City, Mo., industrial and agricultural chemicals, plans power house at proposed new plant near Vicksburg, for production of anhydrous ammonia. It will comprise several large units for processing and general production. Entire development is reported to cost close to $15,000,000, and will require a number of months for completion.

Ravenna, Mo. — Ford Motor Co., Dearborn, Mich., plans power house at new assembling plant at Claycomo, near Ravenna, where large tract of land has been selected. It will comprise a main one-story building and several smaller structures, totaling 1,000,000 sq. ft. floor space, in all. Entire project is reported to represent an estimated investment of close to $25,000,000. Work will proceed at once.

Marcus Hook, Pa. — Sun Oil Co., 1608 Walnut St., Philadelphia, Pa., plans extensions in power plant at oil refinery at Marcus Hook, with installation of additional equipment for increased capacity. Work will be carried out in connection with large expansion program at refinery, reported to cost about $8,000,000. Work scheduled for completion in fall of 1952. Project has been approved by National Production Authority.

Shawville, Pa. — Pennsylvania Electric Co., Johnstown, Pa., will proceed with construction of new steam-electric generating plant at Shawville (Clearfield County), estimated to cost about $38,000,000, with transmission lines, power substations and other operating facilities. Completion is scheduled in 1953. Company has arranged financing in amount of $11,000,000 to provide for certain work on this project, as well as other 1951 expansion and improvements.

Hopkinton, R. I. — New England Power Co., 441 Stuart St., Boston, Mass., plans new electric generating station at Hopkinton, reported to cost about $1,000,000. Work will begin at early date. Charles Maguire Associates, Turks Head Bldg., Providence, R. I., are engineers.

Pinopolis, S. C. — South Carolina Public Service Authority, Moncks Corner, S. C., has plans for new steam-electric generating station at Pinopolis, for which work on substructure will be placed under way soon. No official estimate of cost announced. Ford, Bacon & Davis, Inc., 39 Broadway, New York, N. Y., is consulting engineer.

Rutland, Vt. — Central Vermont Public Service Co., 121 West St., has plans under way for new hydroelectric generating station, estimated to cost about $2,100,000. Project has been approved by National Production Authority and work is expected to be placed under way soon.

Wauwatosa, Wis. — Milwaukee County Department of Institutions, Wauwatosa, has authorized plans for new steam-electric power plant on Watertown Plank Rd., near Wauwatosa, for central power and heating service for certain county buildings. Cost estimated about $4,000,000. Details of project will be determined soon. Pfeiffer & Shultz, Wesley Temple Bldg., Minneapolis, Minn., are consulting engineers.

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NEW ORLEANS
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WHEREVER YOUR LOCATION...

YOU ARE ALWAYS CLOSE TO CLEAVER-BROOKS FACTORY-AUTHORIZED SERVICE

CLEAVER-BROOKS steam boiler service facilities are national — to enable you to get the most in performance through proper care and maintenance of your boiler.

YOU GET...

Starting Service: Boilers are placed in operation by Cleaver-Brooks field representatives who check installation, operation, and make a complete and detailed Field Report to you and to Cleaver-Brooks.

Operation Manuals: Your operators are trained in care and operation by Cleaver-Brooks and furnished with comprehensive, easy-to-understand operation manuals.

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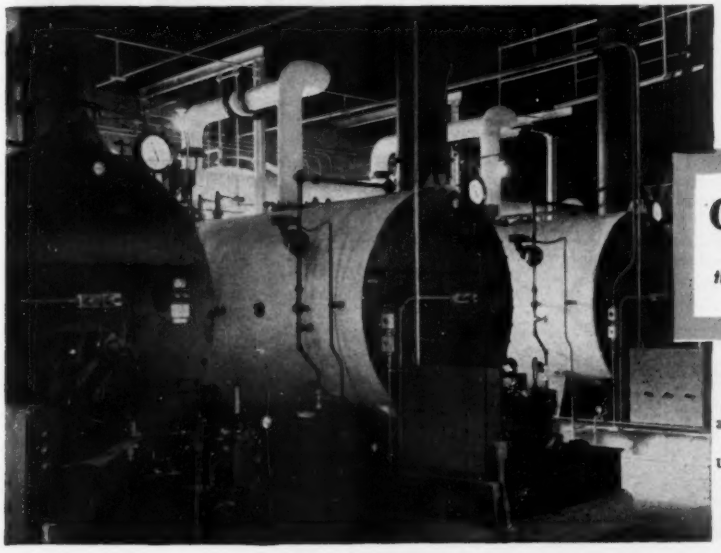
to equip with Cleaver-Brooks — steam boilers that operate at a guaranteed efficiency of 80% — burn gas, oil, or combination gas and oil — fully meet all codes — standard models available in sizes 15 to 500 hp.; 15 to 200 PSI.

* Just a few of the many Cleaver-Brooks authorized service centers



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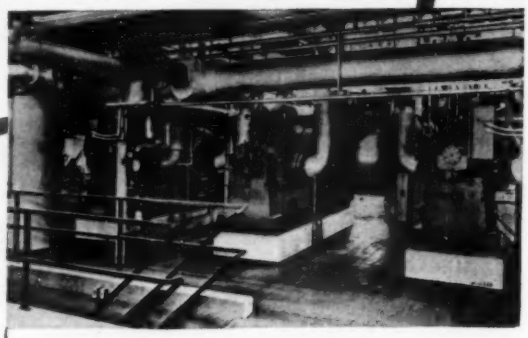
Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners

What Metals Are Best For Centrifugal Boiler Feed Pumps?

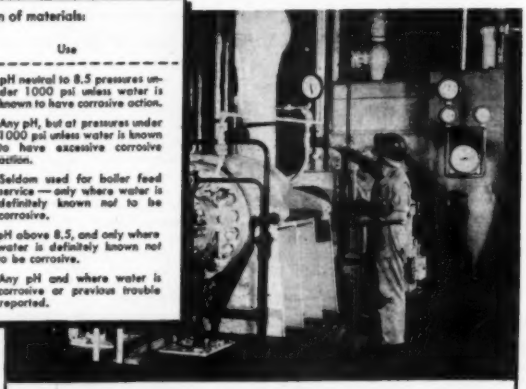
Drawing on their long experience in the field of hydraulics, Worthington engineers produce boiler feed pumps that are metallurgically correct in design, meeting every requirement as to temperature, pressure and corrosion-erosion resistance. As a result, Worthington boiler feed pumps perform better and last longer.



Three Worthington Axially Split Centrifugal Boiler Feed Pumps At The Kansas Power And Light Company Plant, Hutchinson, Kansas.

The following table represents Worthington's recommendation of materials:

Casing	Fittings	Maximum Temperature	Use
1. Cast Iron	Bronze	250 F	pH neutral to 8.5 pressures under 1000 psi unless water is known to have corrosive action.
2. Cast Iron	13% Chromium Stainless Steel	350 F	Any pH, but at pressures under 1000 psi unless water is known to have excessive corrosive action.
3. Carbon Steel	Bronze	250 F	Seldom used for boiler feed service — only where water is definitely known *not* to be corrosive.
4. Carbon Steel	13% Chromium Stainless Steel	400 F	pH above 8.5, and only where water is definitely known *not* to be corrosive.
5. 5% or higher Chromium Steel	13% Chromium Stainless Steel	Any temperature normally encountered	Any pH and where water is corrosive or previous trouble reported.



One of Several Solid Barrel, Radially Split, High Pressure Boiler Feed Pumps at the Trenton Channel Station of the Detroit Edison Co.

This proven selection of materials coupled with the most advanced design, superior workmanship and a thorough knowledge of application show why . . .

THERE'S A *RIGHT* WORTHINGTON PUMP FOR YOU

. . . *right* for the pressure and temperature of your boiler feed service . . . *right* for maximum economy and dependability. For further proof that *there's more worth in Worthington*, contact our nearest District Office, or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

WORTHINGTON

C1.2

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1000 Ft.

For Hotwell, Condensate, Chilled Water Service
Capacities to 1400 GPM
Heads to 650 Feet

For Boiler Feed Service
Capacities to 1500 GPM
Heads to 1600 Feet

For Water Works, Circulation, Drainage, General Service
Capacities to 135,000 GPM
Heads to 400 Feet

For Boiler Feed Service
Capacities to 1600 GPM
Heads to 3300 Feet

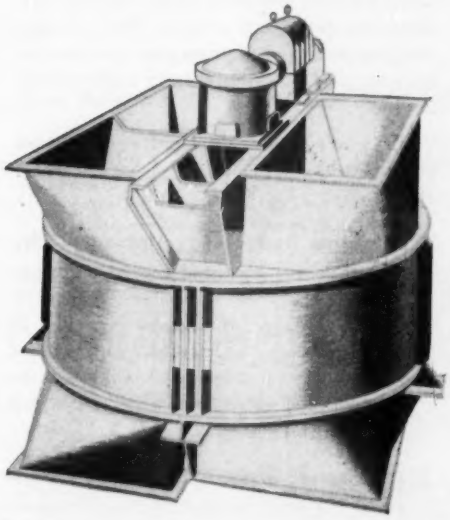
For Boiler Feed Service
Capacities to 3000 GPM
Heads to 7000 Feet

GET ALL 3 with the LJUNGSTROM AIR PREHEATER

- ✓ Improved Combustion
- ✓ Better Heat Recovery
- ✓ Plant Material Savings

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

If you want to improve the combustion of low-grade fuels . . . raise the level of heat recovery . . . conserve critical materials in plant design . . . you or your consultants can make profitable use of Preheater experience. Let our specialists tell you more about the Ljungstrom Air Preheater, and the outstanding job it has done for hundreds of America's leading industries and public utilities, where the need for preheated air from 300F to approximately 1200F was part of their problem. Our engineers are ready to work with you in applying the Ljungstrom to your own heat recovery problem.



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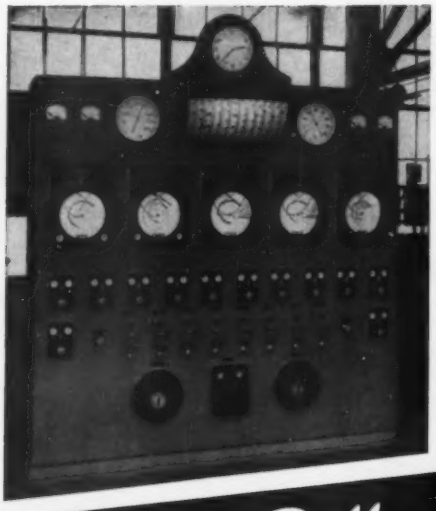

This Bailey Boiler Control Panel in a mid-western industrial plant saves fuel and insures safe operation of a 100,000 lb per hr, 175 psi, sat., pulverized coal and gas-fired boiler.

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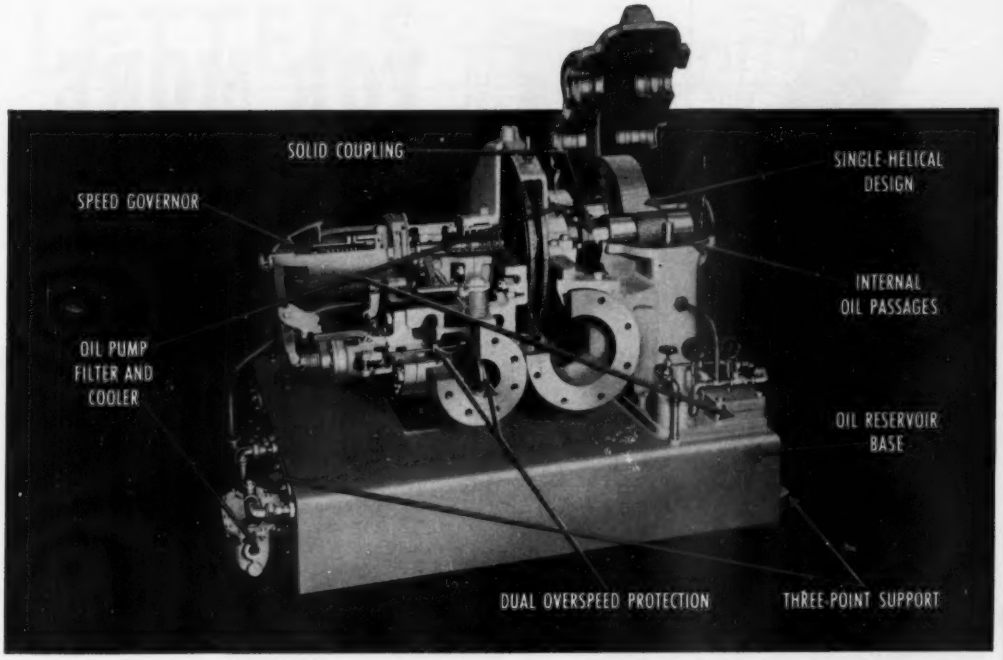

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3-point support for maximum ease in leveling and aligning.

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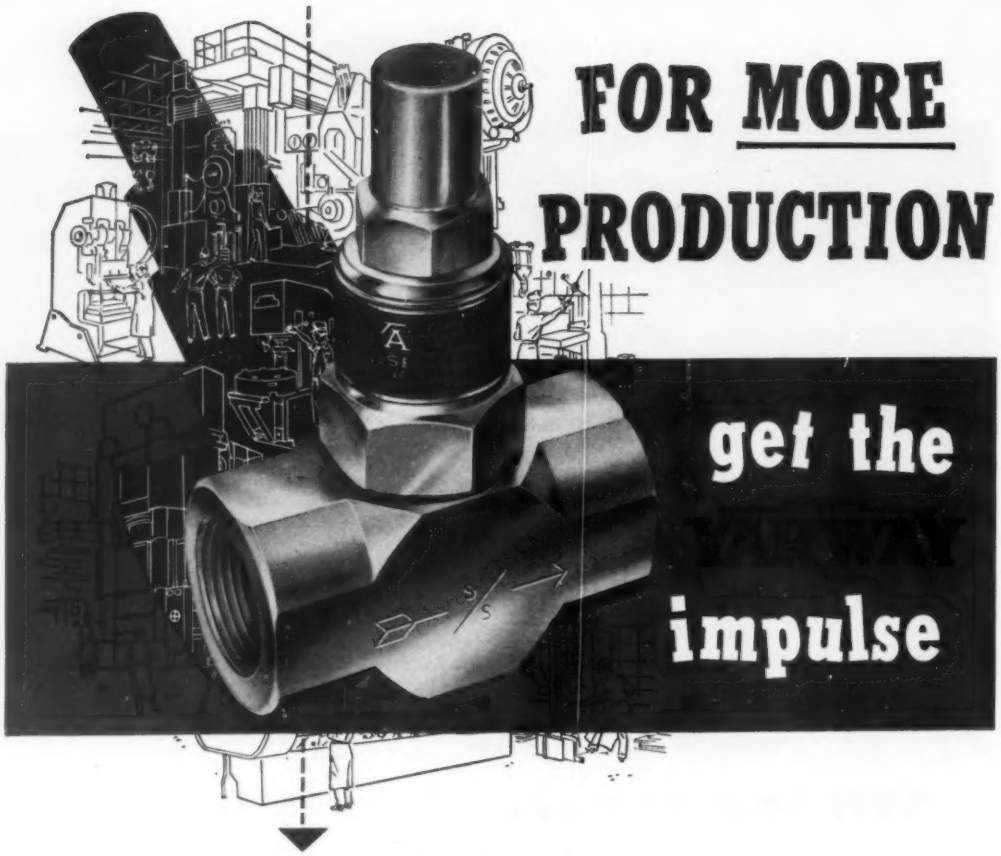

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LETTERS TO THE EDITORS

WATER SUPPLY MAGIC

I HAVE READ with interest and amusement Mr. Sandstrom's remarks in the August issue concerning the proposed vacuum stills for fresh water production. Much of what Mr. Sandstrom has to say is true, although I believe he is mistaken in his conception of the function of the fan and the condensing process.

While I have not read the Los Angeles *Times* account of this process, from the Editor's Note and Mr. Sandstrom's remarks, I believe that the idea is a vapor compression process, carried out under vacuum instead of atmospheric pressure. In other words, the fan is used to compress the vapor from 29.38 in. Hg vacuum to say 29 in. Hg vacuum. The 29-in.-Hg-vacuum vapor is then passed through the tubes and condenses at 79 F, while delivering the heat of condensation to the surrounding incoming water at 65 F, effectively supplying the heat of vaporization.

In boiling at 65 F and condensing at 79 F, there is a difference in latent heats of 1057.1−1049.2 or 7.9 Btu per lb, which must be added to the evaporating process if it is not to gradually run down. Part of the 7.9 Btu comes from a heat exchange between 79-F liquid condensate and the 65-F incoming water.

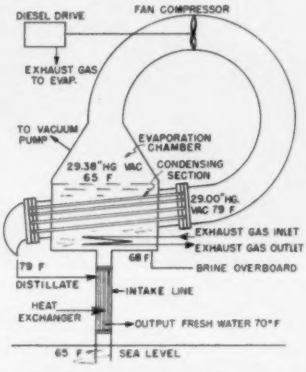
In salt-water evaporation, only one pound can be evaporated from every three pounds of feed in order to keep the salt concentration in the overboard line from getting so high that scaling becomes an insuperable obstacle. This means that for every pound of 79-F condensate cooled 3 deg, the incoming 65-F water will be heated 1 deg, so that cooling the condensate to 70 F means raising the incoming feed to 68 F or adding 3 Btu per lb, still leaving 4.9 Btu to be added. The remaining 4.9 Btu per lb is made up by passing the exhaust gas from the Diesel fan drive through a heat exchanger located in the evaporating chamber. See the sketch.

The question of maintaining the vacuum is answered by continuous operation of a steam-jet air ejector or mechanical vacuum pump to remove the air absorbed in the raw water. This amounts to 2.77 cu ft of free air per 1000 gmp raw water at 65 F. The vacuum pumps actually start the process by evacuating the evaporator space and lifting the water above sea-level to barometric height, depending on the water temperature. Addition of heat to the water from the Diesel exhaust causes evaporation from the surface and puts the process in operation. As the process proceeds, less and less heat is required from the exhaust gas until equilibrium is reached.

I do not mean to imply that I believe the idea is practical, although I understand that this and similar systems are under study, and various reports have been issued in the press.

One thing can be said for low-temperature compression systems over the high-temperature system and that is: the scale formed would be soft instead of hard. Size of the equipment involved, as Mr. Sandstrom points out, is prodigious, to say the least. It is my guess that it would be cheaper to pump and/or pipe water 1000 miles.

If Mr. Sandstrom thinks the proposed vacuum distillation method for city water supplies is fantastic, he should work for a corporation like



mine that is actually engaged in designing and producing evaporation equipment. People walk in with ideas on the subject that defy practicability — let alone the laws of Nature.

Hoboken, N. J. A. LEVINE
Condenser Service & Engineering Co., Inc.

STINSON'S GOOD!

MY COMPLIMENTS to L. S. Stinson for that fine article in your July issue on How to Keep Your Steam Jet Ejectors up to Snuff. That is one of the clearest, best-written and practical sets of instructions I have seen.

My compliments to POWER ENGINEERING too for having the good judgment to publish it. One reason for this bouquet is that the article came at exactly the right time to help me solve an ejector problem.

The ejectors in our power plant have never given us any trouble, but out in one of the plant processes is an ejector producing a vacuum in certain process equipment, and that vacuum has been slowly decreasing.

Well, I was stumped. I couldn't find the cause of the trouble and was just about ready to call for help from the ejector manufacturer. Just then, your July issue arrived; and the minute I read Stinson's trouble tip-offs, I knew what to look for.

Sure enough, on opening up the ejector and taking out the nozzle, I found a groove right down through the nozzle threads — just what Stinson said would cause a gradual loss of vacuum.

The nozzle itself seemed in good condition, so we easily and quickly made a new nozzle plate in our own shop, fitted new gaskets, put the ejector back into service and it now pulls the required vacuum.

Chicago, Ill. E. C. REED

RUBBER POLICEMAN

WHAT IN the name of heaven is a rubber policeman?

I have just been reading carefully, for the first time, that very fine article entitled A Power Plant Laboratory, by S. M. Sperry of Gilbert Associates, in the April 1951 issue of POWER ENGINEERING.

Well, anyway, there on page 67 in the list of laboratory glassware and supplies that Mr. Sperry recommends for a well-designed power plant laboratory of this kind, is the following:

Rubber Policeman.....3

Here in Chicago I thought we had every kind of policeman known; but I have scratched a hole through my hat trying to figure out what kind this one is. Information, please!

Chicago, Ill. AMBITIOUS AL

Editor's Note:—Heh! Heh! Heh! We're 'way ahead of you, Al. We asked Mr. Sperry about it.

A rubber policeman, he says, is used for removing precipitates from the walls of beakers or dishes used in the laboratory. The rubber policeman is generally made of transparent, pure gummed tubing about 1 in. long and ⅛ in. or 3/16 in. in diameter, with one end flattened. A glass rod about 6 in. long is inserted in the open end of the tubing to form a handle.

RED FACE DEPARTMENT

REFERRING to September issue, page 108, it is a bit difficult to appreciate that one becomes eligible for the Obituary column when elected head of a large and important international engineering society.

Presumably this is only a "typographical error" — shall we say?

Montreal, Canada ALF MALKIN

Alibi Department

Yes, we shall say. How four gimlet-eyed proof readers, editors and makeup men permitted the announcement of F. O. McMillan's election as 1951–1952 president of AIEE to become the first item in the obituary department, we shall never know.

With heads bowed in embarrassment, we offer most humble apologies to Prof. McMillan, the AIEE and everybody concerned. — The Editors

BOKARO—U. S. Power

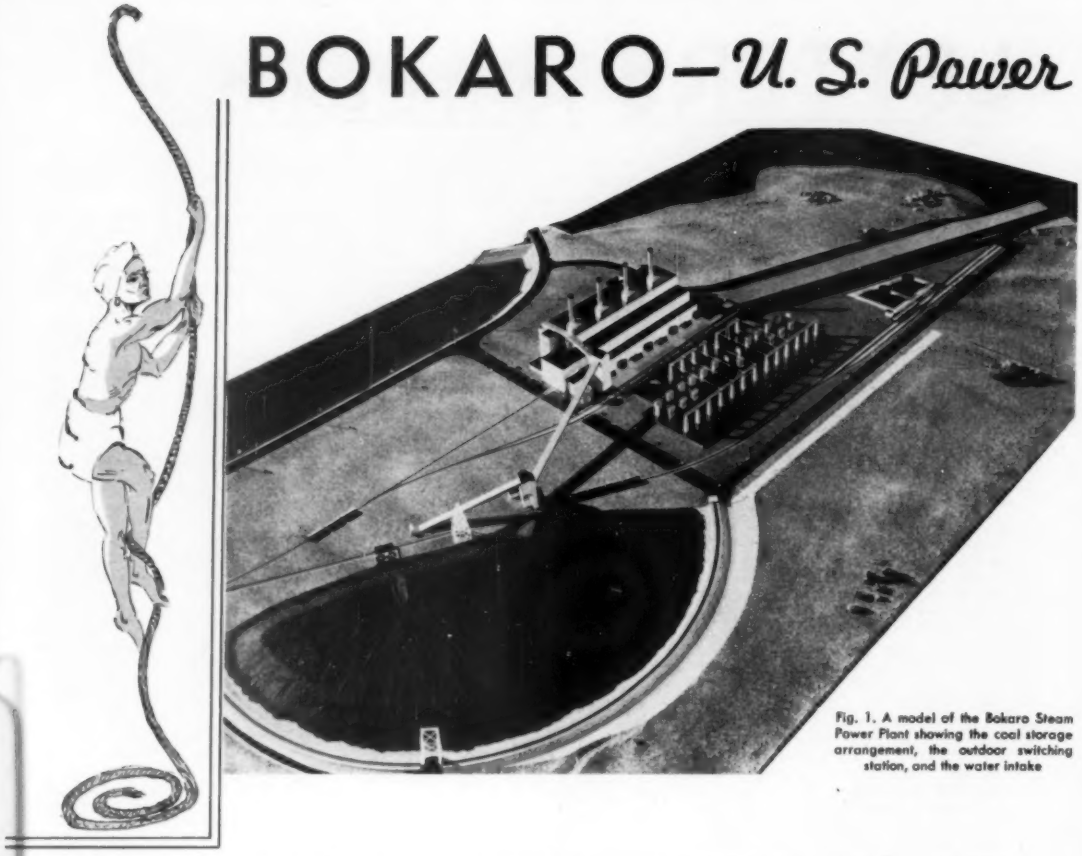


Fig. 1. A model of the Bokaro Steam Power Plant showing the coal storage arrangement, the outdoor switching station, and the water intake

THE BOKARO STEAM POWER PLANT of Damodar Valley Corp., a government financed public utility, will supply electrical power principally for the development of industries. Now under construction in Bokaro, 200 miles northwest of Calcutta, India, this thermal plant is a part of an over-all project of electrical generation which also includes 9 hydro-electric stations to be located on various rivers.

The 4-fold purpose of the project is to control the flood waters during the monsoon season, control land erosion, provide water for irrigation, and provide electrical generation for industrial expansion in one of the richest mineral regions of the country. In many respects the Damodar Valley Corp. of India is similar to the Tennessee Valley Authority of the United States. The hydro-electric plants, totaling 198,950 kw, were designed and are being constructed by Damodar Valley Corp. personnel.

Initial equipment for the thermal plant will consist of three 50,000-kw turbine generator units. The plant has been laid out on the unit system basis of 2 boilers feeding a single turbine. Another 50,000-kw unit, to be installed in the near future, will bring the ultimate capacity to a nominal rating of 200,000 kw or 240,000 kw max. The first 3 units are scheduled for initial operation in Aug. 1952, Oct. 1952 and Dec. 1952, respectively. The station is designed for pulverized coal firing, the supply for which will be obtained from strip-mines within two miles of the plant. Coal will be transported to the station site by means of an aerial ropeway system.

Fuel Handling Systems

The dual coal handling system is of the belt conveyor type capable of handling "run of mine" coal as unloaded from aerial ropeway system or from railroad cars, or "crushed" coal re-claimed from the storage yard. A drag scraper is also provided for stocking out and reclaiming the coal from the storage yard.

A pump house is provided at the railroad siding and trucking areas, housing two 150 gpm lighting oil transfer pumps. The pumps will transfer the oil from the tank cars or trucks to two 3600 bbl, 30 ft dia storage tanks. Lighting oil is fed by gravity to two 600-gph pumps located in the plant basement. Each boiler is fired by 4 burners each of which is equipped with a mechanical atomizing type oil gun.

Ash Handling System

The plant ash handling system is designed to handle bottom ash at the rate of 240 tons per hr or fly ash at the rate of 60 tons per hr. These capacities are based on the use of coal having maximum ash content of 31 per cent, and ash removal once per 8-hr shift. Although only 6 boilers are now being installed, design of ash removal equipment permits future total of 8 boilers.

The bottom ash or ash accumulated in the furnace hopper of each steam generating unit is removed by means of an hydraulic system. The system consists of oscillating feed nozzles to move the ash from each hopper to the sluiceway, along which the ash is conveyed by transport nozzles to the clinker grinders mounted adjacent to the ash pit.

To insure a minimum water pressure of 125 psig at the oscillating and transporting nozzles, 3 vertical, 1800 gpm, 150 psig ash water pumps are provided, one of which will act as a spare. Two 4000 gpm ash pumps are provided, either of which is capable of handling the combined ash and

Engineering Exported to India

In the article on Technical Aid for Foreign Power Projects published in the June issue, brief reference was made to the Damodar Valley power development project in India, 200 miles northwest of Calcutta, where the Kuljian Corporation is constructing the Bokaro Steam Power Plant. This thermal plant is part of an overall project of electric generation which in many respects is similar to our own Tennessee Valley Authority. Since the Bokaro Steam Plant is being built by an American firm with American equipment, the engineering details should be of particular interest, and we are pleased to have the privilege of presenting this detailed description here. Mechanical features here; electrical features in future issue

By HRAND H. LEVONIAN
Project Engineer, The Kuljian Corporation, Philadelphia, Pa.

ash removal water from the system. These pumps will transfer the ash and water from the ash pit through specially hardened cast iron pipe to the fill area located east of the power house.

To accommodate the continuous cooling water flow from the furnace hopper deflectors and other miscellaneous plant drains, a concrete bilge sump and two 900 gpm vertical bilge pumps are supplied. The fly ash accumulated in the boiler pass, air heater duct, collector, and stack hoppers is removed by means of a vacuum system. The system contains a hydraulic ejector for each set of two steam generators. The ejector produces a vacuum causing the fly ash to be moved through a pipe system from each hopper to the ejector when the individual hopper dust valves are opened consecutively. The dust is then mixed with the water stream and discharged to the sluiceway.

Control Centers

There are 2 steam generator and turbine control centers located on the operating floor in the turbine bay. The first control center includes panels for steam generators Nos. 1, 2, 3 and 4 and turbine generators 1 and 2. The second control center is just the same except that for the present it includes only panels for steam generators 5 and 6, and turbine generator No. 3. The panels are complete with all normal instrumentation and controls including internally illuminated instruments and remote flame indicators. They are of the enclosed type having bench-type fronts, canopies with fluorescent lights, and are provided with removable sections in the rear for repairs and maintenance. One 54-point annunciator desk is provided opposite each turbo-generator panel and includes a unit intercommunication speaker phone and a private telephone to meet operational emergencies.

There are three steam generator auxiliary control centers located on the operating floor in the steam generator bay. These include instrumentation and controls for superheater control, soot blower control, and boiler operator instruments and phones.

The electrical control of the station is centered on a tunnel type duplex switchboard which is located in the electrical control room on the electrical gallery overlooking the turbine room. This board contains the con-

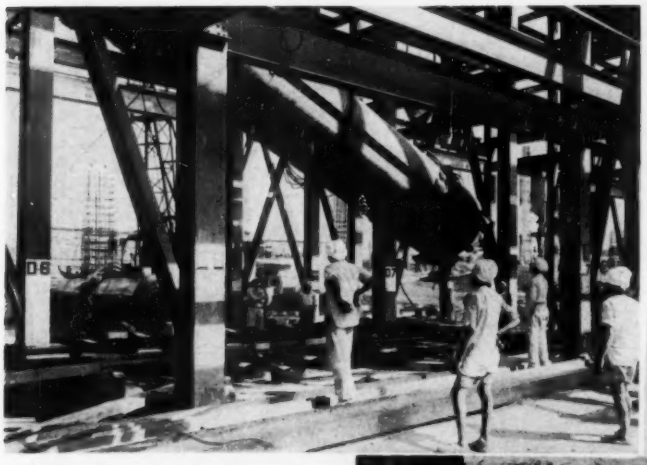


Fig. 2 (Above). Hoisting No. 4 Boiler steam drum into place. Lower drum can be seen in background

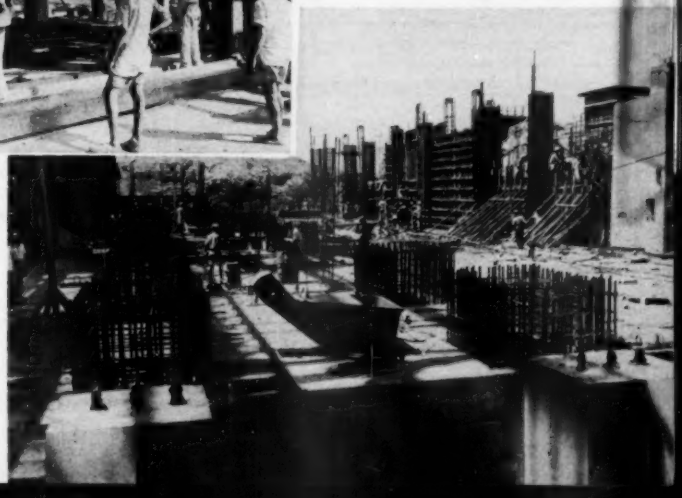


Fig. 3 (Right). No. 1 Turbine-generator mat in the foreground showing steps leading to the condenser hotwell pit. This view was taken from the north end of the building

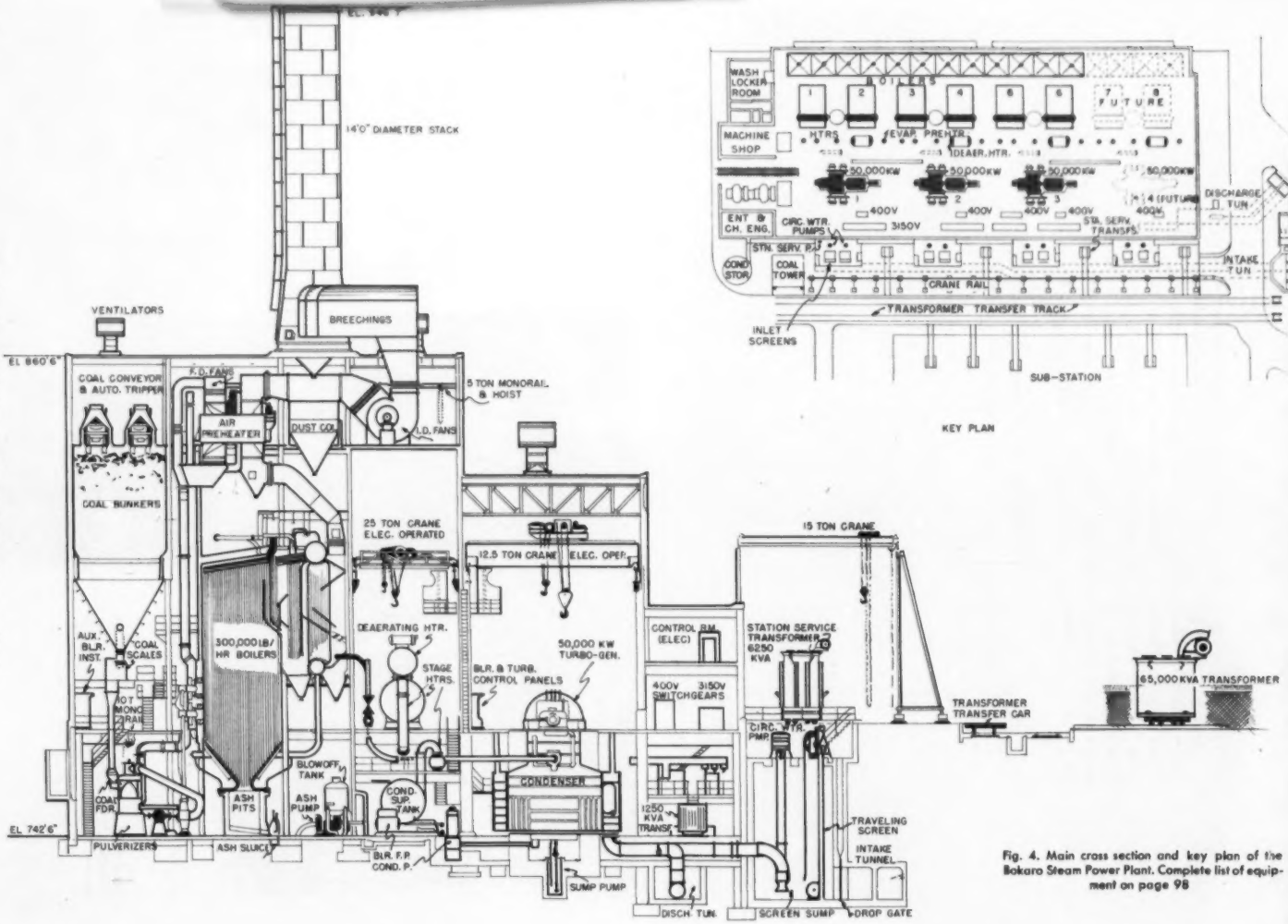


Fig. 4. Main cross section and key plan of the Bokaro Steam Power Plant. Complete list of equipment on page 98

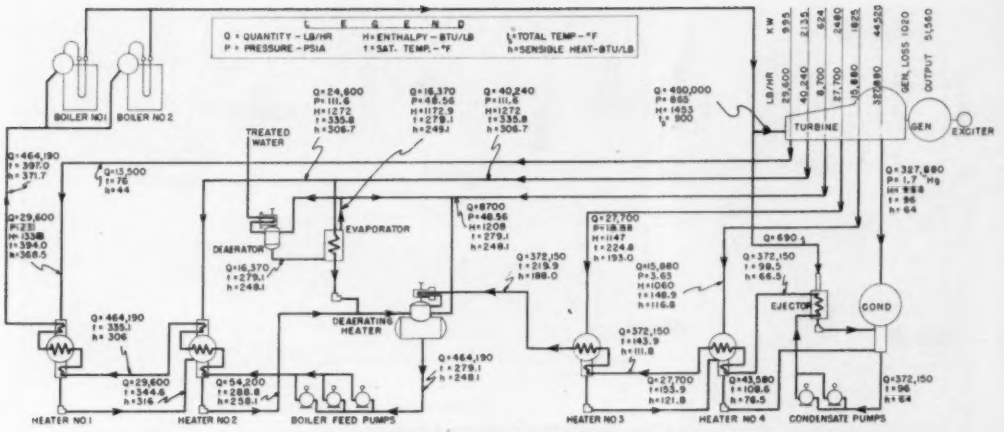


Fig. 5. Heat balance diagram for a load of 51,560 kw

trols for the generators, exciters, generator transformers, station service transformers, and the outdoor substation. Indicating instruments, recording meters, and watt-hour meters are located on the front panels and the relays and voltage regulating equipment are mounted on the rear panels. All relays and watthour meters are of the drawout type with built-in test features. A mimic bus showing all main connections is provided on the front of the switchboard.

Control of the coal-handling system is operated from the coal-handling unit substation located at the crusher house. A control panel on the unit substation contains all of the control switches and lights for the complete operation of the system. In addition, emergency stop switches are located at each motor. Electrical interlocking insures the proper sequence of operation of the equipment.

The ash-handling system is controlled from one central panel and two other smaller stations located in the basement.

Intake and Discharge Structures

Leading from the Konar River to the bar screen structure is a 1200-ft long intake channel that serves as a settling basin for the station water requirements totaling 250,000 gpm. This design is necessary to overcome the extreme turbidity encountered during the monsoon season at which time the controlled river level will rise a maximum of 20 ft. The divided bar screen and stop gate structure is located at the south end of the building and feeds the intake tunnel. Each half of the intake tunnel feeds 2 screen pits, each of which serves one turbo-generator unit. Each screen pit is designed for 2 traveling water screens so arranged that by means of shut-off gates either half of the screen pit may be isolated and dewatered for repairs or cleaning of equipment or pit.

The discharge tunnel runs under the building for its full 450 ft length, then turns and continues southeast to the discharge control structure 1200 ft away. The structure is designed to discharge either above or below the barrage. The normal flow will be below; however, during the dry season when water is scarce, the discharge will be above the barrage.

Mechanical Equipment

The steam generating units are each designed to generate 300,000 lb of steam per hour continuously. The superheater outlet operating conditions are 895 psig with a total temperature of 910 F. The boiler is of the double drum radiant type having a continuous-tube, pendent type, two-stage, superheater with a center gas by-pass and automatic and remote damper position selectors for steam temperature control. Each steam generator is equipped with 4 burners. Two pulverizers are provided per boiler, one feeds the 2 lower burners and the other feeds the 2 upper burners. Each pulverizer is sized to carry 80 per cent of the full load. The station has been designed for pulverized coal fuel only, but heavy duty lighting-off equipment has been supplied to act as pilot torches in case of coal hang-ups. Each steam generator soot blower system consists of the following: 6 manually operated wall blowers; 12 manually operated straight line blowers, and 2 remote electrically operated retractable blowers. The blowing medium for all units is steam.

Steam temperature of the superheater outlet of each unit is automatically controlled by electrically operated equipment designed to regulate the flow of hot gases over the superheater sections.

An automatic air operated combustion control system is provided. Coal firing is controlled in parallel with air supply, the induced draft being readjusted in accordance with steam flow-air flow relationship. The pulverizer feeder and mill exhauster inlet ratio controllers function in accordance with limiting relays to cut down the supply of fuel in proportion to the supply of air available. Furnace draft is maintained substantially constant by automatically positioning the forced draft fan vanes.

The coal bunkers have a capacity equal to 3½ days maximum plant demand. The bunker proper is of concrete with steel discharge hoppers. Each hopper supplies coal directly to a coal scale which in turn supplies coal to the feeder.

Each steam generator is served by a forced draft fan driven by a constant speed motor. Volume regulation is obtained by inlet vanes operated by air-actuated controls. Each

(*Continued on page 98*)

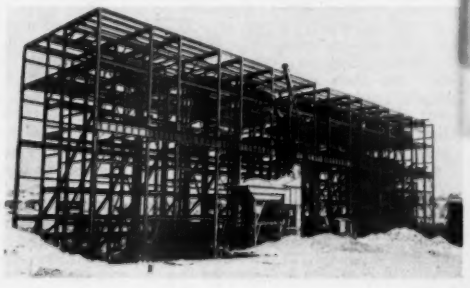


Fig. 6. View from southeast corner showing boiler house steel

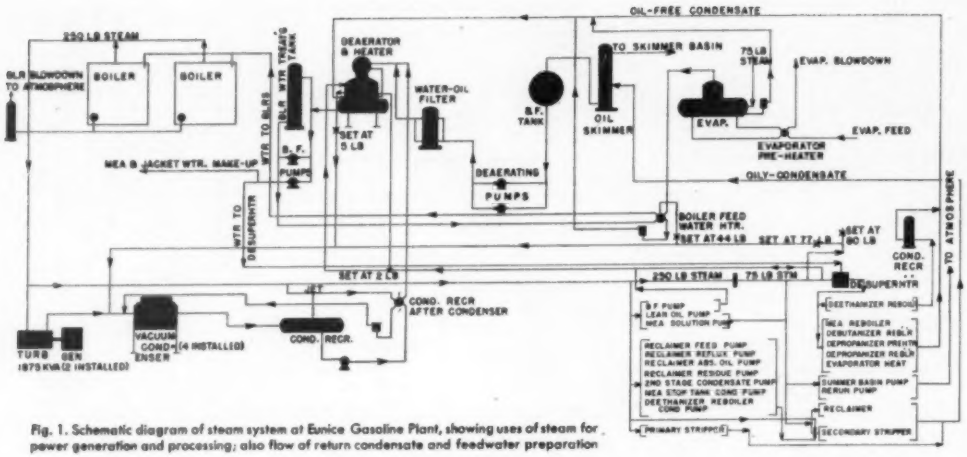


Fig. 1. Schematic diagram of steam system at Eunice Gasoline Plant, showing uses of steam for power generation and processing; also flow of return condensate and feedwater preparation

Air-Cooled Steam Condensers Serve Eunice Plant—60 Miles from Water

Sixty miles from nearest suitable water supply, this plant handles 70 per cent of total cooling load with air-cooled exchangers . . . . This is the Eunice Gasoline Plant, producing gasoline and other products from gas produced with oil in surrounding fields . . . . Air-cooled units serve condensing turbine generators, also condense excess steam from other operations . . . . Plant processes require operation of two 1875-kva condensing turbine generators, supplied with 245-psig steam and exhausting at 3 psia to a battery of four air-cooled steam condensers, capacity 28,000 lb per hr each . . . . Boilers fired with ethane . . . . Complete description of power plant, flow diagram, performance data

By H. T. GRIFFIN, *Plant Superintendent and* **JOHN HOOVER,** *Plant Engineer*

Eunice Gasoline Plant, Gulf Oil Corp., Eunice, N. M.

AIR-COOLED units are successfully handling the exhaust from condensing-type turbines, as well as condensing excess steam from other operations, at the Gulf Oil Corporation's Eunice Gasoline Plant located near Eunice, Lea County, in southeastern New Mexico. Since this is a very arid section with the nearest stream of any size approximately sixty miles away, it is very important that water consumption be held to a minimum. The policy of water economy has been followed throughout all plant operations and nearly 70 per cent of the total cooling load is handled by air-cooled exchangers.

The Eunice Gasoline Plant handles from 55,000,000 to 60,000,000 cu ft per day of gas produced with the oil in the surrounding fields. The gas comes into the plant at 10 psig pressure and is compressed in three stages to 900 psig by 12 two-cycle gas-engine-driven compressors having a total horse power rating of 15,600. By counter-circulating monoethanolamine solution on the second-stage discharge, the corrosive hydrogen sulfide is removed. Natural gasoline, propane and butane are removed by interstage cooling and scrubbing and by counter-circulating a light gas-oil at the third-stage discharge. The gas residue from these operations is dried to remove water vapor and delivered to utility company lines for transmission to California. The liquid products are disposed to pipeline, tank cars and tank trucks.

The plant requires steam to drive the turbine generators, the turbine-driven pumps, reciprocating pumps, for heat in the reboilers and as stripping steam in the absorption oil rectification process. The 1200-kw output of the generators is used for pumping water wells, for engine-jacket-water circulating pumps, for water-treating pumps, cooling-tower pumps, process feed and reflux pumps, liquid-product loading pumps, fan motors for air-cooled units and plant lighting.

The steam and electrical generating section of the plant is equipped with two boilers, two generators, four air-cooled steam condensing units, one condensate receiver with jet condenser, one deaerating heater, one evaporator unit for boiler makeup, one oil filter unit and two boiler feed pumps.

The steam generating equipment consists of two Wickes type A three-drum, bent-tube-type boilers, each having a capacity of 60,000 lb per hr of steam at 250 psig and 600 F total temperature. While both boilers are operated continuously, either will carry the entire plant load. Waste ethane from the extraction operations is used for fuel. It has a Btu value of 1790 and is injected through rotary type burners. The boilers are the induced-draft type and the fans are

Fig. 2. General view of the four air-cooled condensers

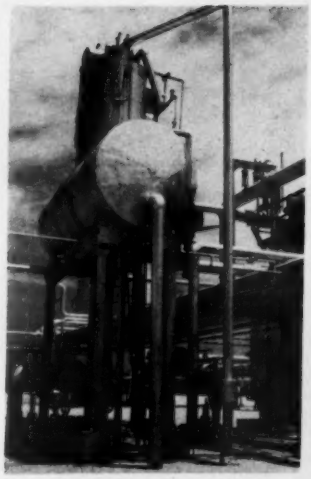


Fig. 4. Close-up of tray-type 80,000-lb-per-hr deaerating heater with 2200-gal storage

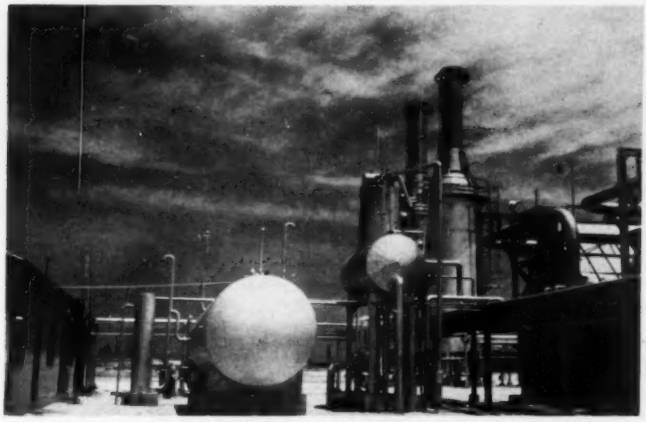


Fig. 3. Boiler feedwater reserve tank (left foreground) and 80,000-lb-per-hr deaerating heater (right foreground). Refinery equipment in background

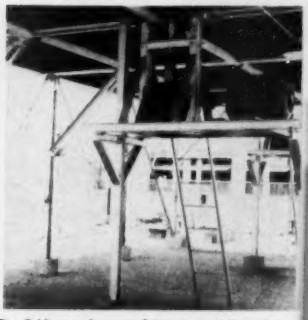


Fig. 5. View under one of the air-cooled condensers showing mounting platform for motor and right-angle gear-box drive to vertical fan shaft

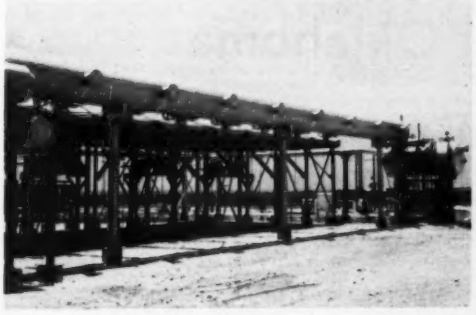


Fig. 6. View of turbine exhaust manifold carrying exhaust steam to condensers; condensate receiver tank in background (See Fig. 1)

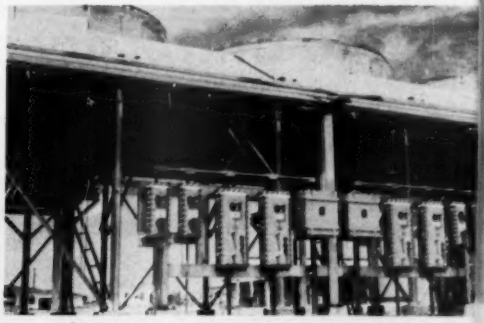


Fig. 7. View of the two-speed switch controls on the four 25-hp motors on fan drives of the air-cooled condensers

all driven direct by electric motors.

Boiler feed consists of clean condensate from process operations and the turbine condensers, oily condensate from the absorption oil strippers and distilled make-up. The clean condensate goes directly to the 80,000-lb-per-hr tray-type deaerating heater, which has a storage capacity of 2200 gal. It operates at about 2 psig.

The oily condensate, contaminated only with the light absorption oil, returns to a vertical-type oil skimmer and from it is siphoned to the boiler feed reserve tank. The deaerator make-up pumps take suction from this tank and pump through a diatomaceous-earth-type filter for removal of any traces of oil to the deaerator.

Make-up for the boiler is provided by a horizontal, single-effect, bent-tube-type evaporator having a ca-

(*Continued on page 120*)

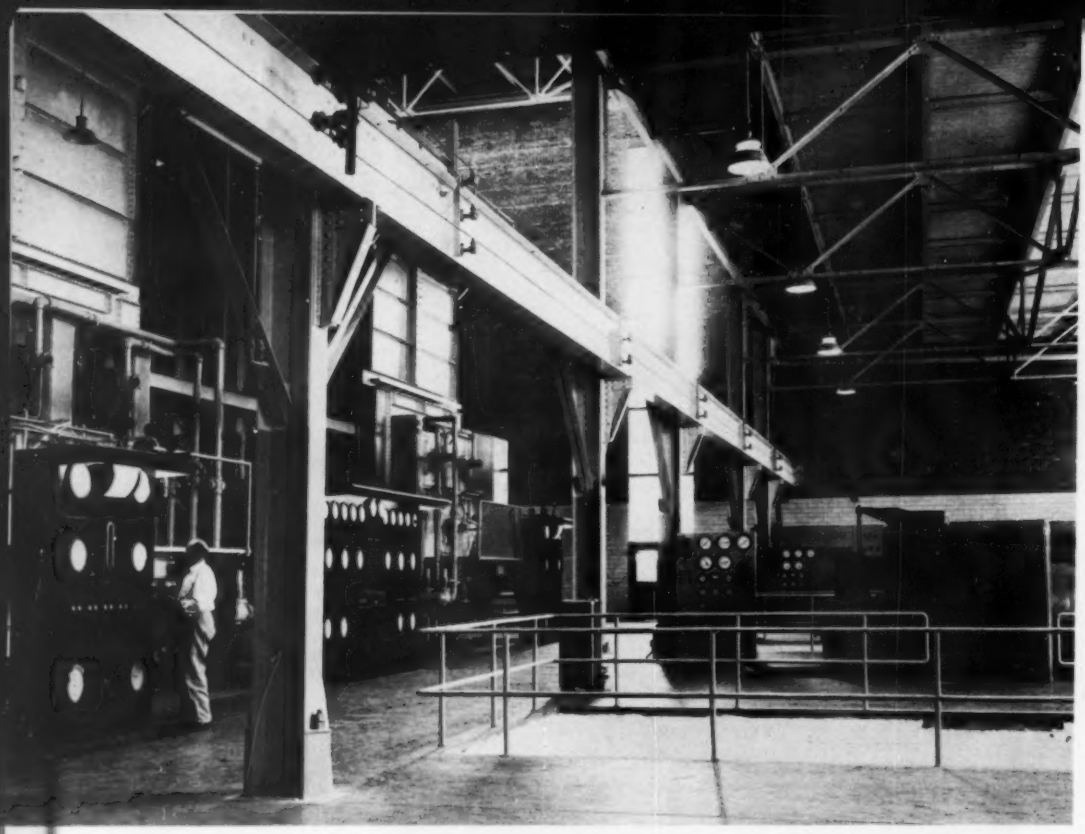


Fig. 1. General view on operating floor of new University of Oklahoma power plant, showing the two 50,000-lb-per-hr boilers and their control panels; and, at right, steam end of one of the two 2500-kw turbine generators. Note ample space for present operation and future additions

Modern Power Backs Modern Education At The University of Oklahoma

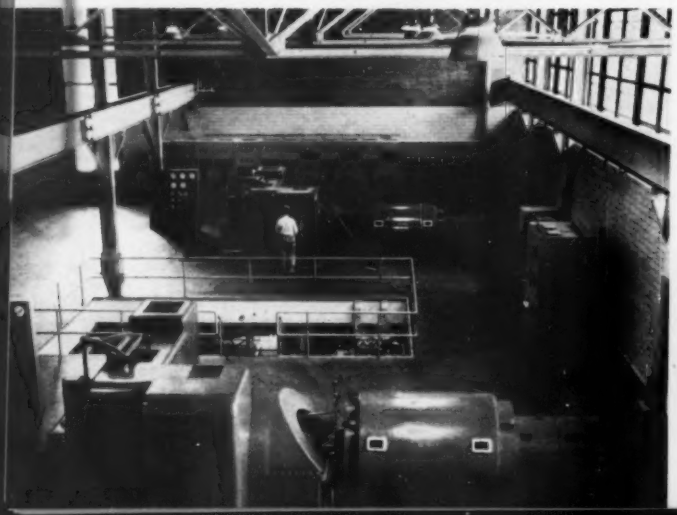


Fig. 2. (Left). Here are the two 2500-kw turbine generators, their control panels, and the electrical switchgear for controlling their output

Fig. 3. (Below). Pleasing modern design characterizes architecture of power plant building. Note motor-operated continuous windows near roof line, for both light and ventilation

THIS MODERN power plant, located on The University of Oklahoma Campus, at Norman, Oklahoma, was placed in operation on October 14, 1950. This plant consists of two 2500-kw turbine generators, supplied with 425-psi, 725-F steam by two 50,000-lb-per-hr gas-or-oil-fired boilers.

During preliminary design of this plant, extensive studies were made of the past and present requirements for electrical energy, process and heating steam required by all the buildings on the Campus. From these studies, combined with the University's near future building program, the installed capacity of the power plant was established. Projecting these studies into the future, the engineers provided ample space within the building for future equipment to satisfy the contemplated ultimate growth of the University.

With the required capacities established, preliminary lay-outs were made, specifications were written, and contracts were awarded on the major items of power plant equipment: steam and power generating equipment, firing equipment, fans, ductwork, breechings, stacks, platforms and so on, condensers, feed pumps, switchgear. Full technical details of these are given in the list of equipment on the next page.

With these major items of power plant equipment under contract, the architect-engineers then designed the building, piping, valves, controls and miscellaneous accessories.

One Boiler per Turbine

Fundamentally, the plant was designed on the unit system, in which a single boiler serves one turbine-generator unit. Initial installation consisted of two boilers with space for two additional, and two 2500-kw turbine-generator units with space for an additional future 5000-kw unit.

Steam condensers, circulating water pumps, fuel oil pumps and heating system, vacuum pumps serving the campus heating system, air compressors, blow-off tank, pressure reducing valve and desuperheating station are all installed in a full basement below the operating room floor. All the piping, except for the steam risers at the rear of boilers, which serve the forced-draft and induced-draft fan turbines located on the fan deck 36 ft above the operating-room floor, is run at the basement ceiling.

Raw water is introduced into the system through the make-up deaerating heater and the evaporators. Condensate from the condenser hotwells and from the Campus heating system is pumped into the feedwater deaerating heater and/or to a 5000-gal surge tank mounted in the roof trusses. An underground concrete basin is available for the storage of condensate. Through a system of float valves, all

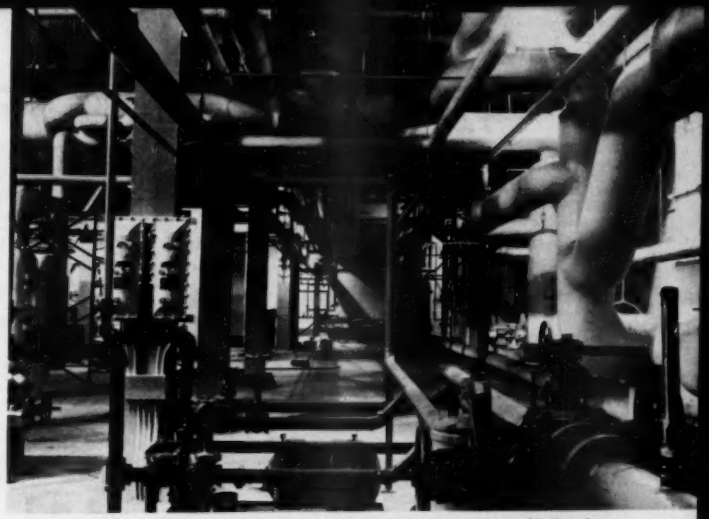


Fig. 4. Most of the piping, except for boiler risers, is run at basement ceiling, as this view shows

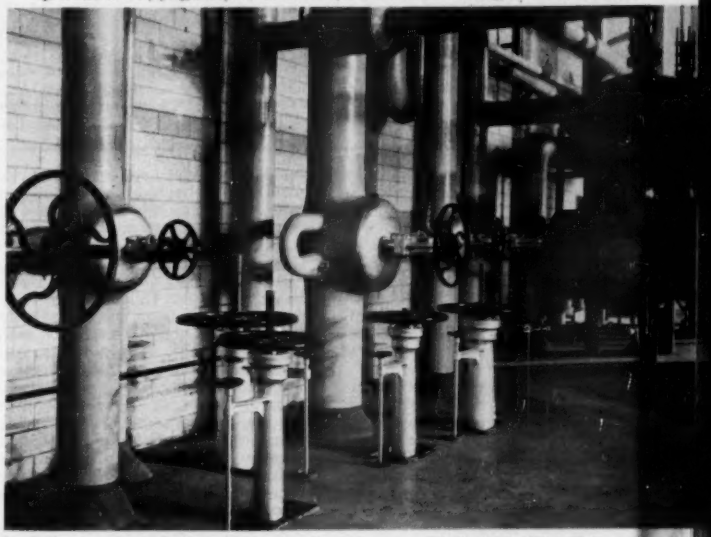


Fig. 5. Here is a detail of piping, showing attractive appearance and attention to detail. Note small auxiliary floor stands for operating valve by-passes from operating floor

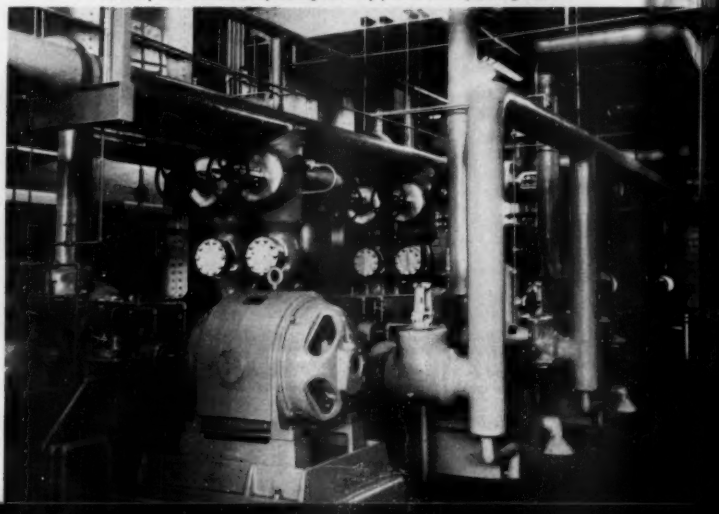


Fig. 6. Here are the three 300-gpm boiler feed pumps, one motor-driven, two turbine-driven

Principal Equipment—New Power Plant—The University of Oklahoma, Norman, Okla.

STEAM GENERATING EQUIPMENT:

Boilers (2)—Springfield Boiler Co. Each with 50,000-lb-per-hr continuous rating, 425 psig, 725 F vertical, bent-tube, two-drum type, with water-cooled furnace walls; heating surface 7,100 sq ft; water-cooled furnace 2,890 sq ft; gas- or oil-fired, with provision for future conversion to pulverized coal.

Superheater—Springfield interbank pendant type.

Air Heater—5650 sq ft; passes arranged to give outlet air temperature of 350 F.

Firing Equipment—3 Webster combination gas and steam atomized oil burners per boiler.

Forced Draft Fan—American Blower Corp. Design basis: Future coal firing; capacity 23,000 cfm, 7.95 in. H_2O, 100 F; inlet-vane and speed control.

Forced Draft Fan Drive—Elliott Co. mechanical-drive turbine; speed reduction gear; throttle steam, 400 psig, 700 F., back-pressure 10 psig; 41 bhp; speed 3720/1860 rpm.; water rate 31.0 lb per bhp-hr.

Induced Draft Fan—American Blower Corp. Design basis: Future coal firing; capacity 41,600 cfm, 5.20 in H_2O, 435 F; outlet damper and speed control.

Induced Draft Fan Drive—Elliott Co. mechanical-drive turbine, speed reduction gear, throttle steam 400 psig, 700 F.; back pressure 10 psig; 56 bhp; speed 4235/847 rpm; water rate 28.0 lb per bhp-hr.

Ducts, breeching, stacks, boiler casing, catwalks and platforms—All included in the Springfield Boiler Co. contract.

POWER GENERATING EQUIPMENT:

Turbine-Generators (2)—Westinghouse Electric Corp. Generators each 2500 kw, 0.8 pf, 3125 kva, 3600 rpm, 3 phase, 60 cycle, 2400/4160 v, air-cooled. Direct connected to Westinghouse turbine; throttle steam 400 psig, 750 FTT, 2 in. Hg. abs; automatic controlled extraction at 10 psig.

Condenser (2)—Westinghouse Electric Corp. Surface type; each 3000 sq. ft; two-pass; non-divided waterboxes; direct connected to turbine flange. 2-stage air ejector, inter- and after-condenser, condensate pump, controllers, etc.

Boiler Feedwater Pumps (3)—Ingersoll-Rand Co. Each pump, 300 gpm, 525 psig, 6 stage. One pump driven by 150-hp, 3550-rpm, 2400-v, 3-phase, 60-cycle Westinghouse motor. Two pumps driven by Westinghouse steam turbines; 400 psig, 750 FTT, 10 psig exhaust.

Cooling Tower (1)—The Floor Corp. Model 46FN-144-24-30-DD, counterflow; induced draft; 8000 gpm, 105 F to 90 F, 78 FWB.

ELECTRICAL EQUIPMENT:

Metal-Clad, 5-Kv, 3-Phase Switchgear Equipment—General Electric Co. This gear has two generator panels (space for third) and seven Compax feeders; each feeder capable of handling ultimate load of 1200 kva at 2.3 kv. Plant lighting and miscellaneous small power supplied at 480 v, 3 phase, from one General Electric 300-kva load center. Separate 5-kv General Electric metal-clad motor control supplies energy at 2.3 kv to one 75-hp, and one 100-hp circulating water pumps, to two 100-hp synchronous motors, and to a future 150-hp induction motor.

PUMPS, AUXILIARIES, PIPING

Combustion Controls and Plant Instrumentation—Bailey Meter Company.

Circulating Water Pumps (3)—Worthington Pump and Machinery Corp.
1—4000-gpm, 70-ft head, driven through flexible coupling by Westinghouse 100-hp, 1200-rpm, 3-phase, 60-cycle, 2400-v drip-proof motor.
1—2700 gpm, 70-ft head driven through flexible coupling by Westinghouse 60-hp, 1800-rpm, 3-phase, 60-cycle, 2400-v drip-proof motor.
1—1300-gpm, 70-ft head; driven through flexible coupling by Westinghouse 30-hp, 1800-rpm, 3-phase, 60-cycle, 2400-v drip-proof motor.

Raw Water Make-Up Deaerating Heater (1)—The Swartwout Co. Capacity 10,000 lb per hr; 60 F to 210 F; operated on 5 to 15 psig steam. Storage 6.0 cu ft.

Boiler Feedwater Evaporators (2)—The Griscom-Russell Co. Capacity 3000 lb per hr, vapor 10 psig; operates on 20 to 25 psig steam.

Boiler Feedwater Deaerating Heater (1)—Elliott Co. Capacity 180,000 lb per hr. Operates on 5 psig steam; boiler feed-water 210 F to 220 F.

Fuel Oil Pumps (2)—Schutte and Koerting Co. One 20-gpm, 200-psig discharge pressure. One 10-gpm, 200 psig discharge pressure.

Fuel Oil Heater (1)—The Griscom Russel Co. 6 G-R Twin G-Fin sections; capacity 13,500 lb per hr; No. 6 oil from 40 F to 150 F; 75 psig.

Piping and Valves—Crane Co.; Golden-Anderson Valve Specialty Co. Many important components of piping systems pre-fabricated in Crane Co. shops.

Pressure Reducing and Control Valves—Fisher Governor Co.

this stored condensate is made automatically available to the boiler feed pumps.

The building was designed with a wide operating aisle separating the steam-generating units from the turbine generators. Individual boiler control panels on the boiler side and turbine-generator control panels on the opposite side of this aisle, and the master plant-control panel located about midway of the power plant, all combine to form the nerve center for this plant. It is quite possible to view most of the controls for the operation of the plant from a control point in front of the master control panel.

The building was designed to suit the major items of power plant equipment and to provide ample space for the auxiliary equipment. Motor-operated continuous windows near the roof lines of both the boiler and generator sections, as well as other well-placed windows, were provided for an abundance of natural light and ventilation. Construction of the building was by Harmon Construction Co. of Oklahoma City, Okla.

Another contract was awarded for piping and accessories. This work consisted of all piping, valves, controls, insulation and other items of equipment, including field installation of the turbine-generator units and boiler feed pumps. This contract was awarded to the Malcom Murphy Boiler and Heating Co. of Shawnee, Okla., who was also field erector for the boilers, which were purchased on an erected basis.

The condensers, heaters, pumps and other auxiliaries are all located in the basement, as shown, and most of the piping is installed on the basement ceiling. The abundance of light from the well-placed windows, and the absence of piping on the operating floor give the plant and its equipment an appearance of spaciousness that is unusual in small steam power plants. The plant building itself has a most attractive modern, functional design, yet it is not extreme. Careful landscaping adds to its attractiveness.

The new plant was designed by Coston and Frankfurt, Architects and Engineers, of Oklahoma City, Okla. For the technical data and photographs, we are indebted to them and to Walter W. Kraft, Director Physical Plant, The University of Oklahoma, Norman, Okla.

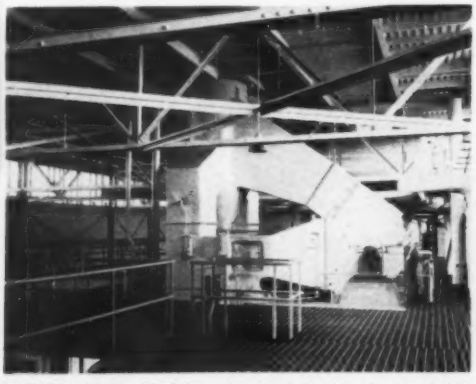


Fig. 7. View of induced-draft fan and duct-work. Fan driven by steam turbine for speed control (plus damper control)

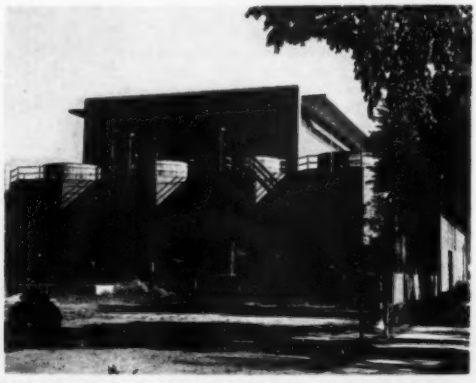


Fig. 8. At one end of the plant stand four sections of counterflow, induced-draft cooling tower

How We Can Reduce the Vibrations That Damage Transmission-Line Conductors

By ROBERT H. NAU

Assistant Professor,

Department of Electrical Engineering,

University of Illinois

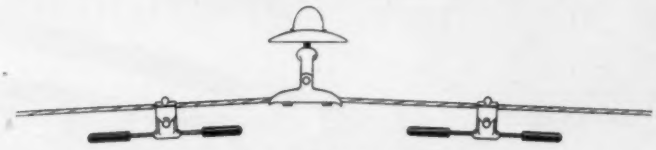


Fig. 1. The Stockbridge damper

CONSIDERABLE attention has been given to conductor vibration of suspended transmission lines during the past 25 years. Even so, the engineers of the public utilities feel that they have only started to get a solution to the vibration problem. Extensive research programs are being conducted at present by manufacturers of conductor cable and by many of the public utilities.

There are two categories of vibrations which have been found to cause breakage of suspended lines near the suspension supports. The two categories are called aeolian vibration and galloping or dancing conductors. It is important to note that each type of vibration has caused conductor failure. The accumulative effects of both, however, hasten rupture of conductors.

Aeolian vibrations are those of the natural frequencies of the suspended span, which are stimulated by very steady winds of 1 to 30 miles per hour. It is the periodically varying eddy turbulence on the leeward side of the conductor that produces the excitation. The frequencies range from 1 to possibly 100 cycles per second, and the amplitudes normally range from a fraction of an inch to several inches. However, aeolian vibration amplitudes of five feet and more have been observed. The frequencies and amplitudes of aeolian vibrations are functions of the wind velocity, the span length, the distance between nodes, the tension in the conductor, the diameter of the conductor, and its weight per unit length. On short spans the vibration is of extremely small amplitude, and it is evident only by the humming sound produced, as the "singing" of telephone lines on clear cold winter mornings.

Stockbridge dampers and Armor rods are two popular means of combating aeolian vibrations. The Stockbridge damper has been found quite effective. It is but a double-cantilever vibrating element, which is suspended in the middle. These dampers are clamped to the conductor span at a distance of one to six feet from the suspension support. One or more is placed on each side.

Armor rods are used chiefly on ACSR conductors. They are constructed by using a layer of aluminum conductors which are somewhat larger in diameter than the outer strands of the ACSR conductor. The layer of aluminum armor is wound with the lay of the outer strands of the conductor for a distance of two to six feet each side of the support. The support clamp is placed on the outside of the armor, and two smaller clamps are used to hold the ends of the armor rod layer to the cable. Armor rods are only about 10 per cent as effective as Stockbridge dampers, but are quite effective on smaller diameter ACSR conductors with short spans.

Galloping or dancing conductors are large-amplitude low-frequency vibrations — up to 10 feet at about one cycle per second. Galloping is caused by strong gusty winds blowing across irregularly ice-covered conductors. No definite means has been found for damping these vibrations. The only known way of eliminating the phenomenon is to prevent the ice from forming or to melt it off as quickly as possible after it forms and before damage occurs. The critical diameter of cable for ice forming is about 1.4 in. — i.e., cable of 1.4 in. in diameter or larger will collect very little ice in heavy storms at freezing temperatures! — a most significant fact.

Consideration of the electric analog for mechanical systems is important. There are three basic vibrating systems of one degree of freedom. These are illustrated in Figs 2, 3 and 4. An examination of the behavior of the mechanical spring system and of the mechanical torsional system reveals that the same differential equation governs their behavior as does that for the LRC electrical system.

Electrical and Mechanical Analogies

There is then one to one correspondence for the basic mechanical and electrical elements. At this time interest is chiefly in the electrical and mechanical linear-spring system. The analogies which arise are: emf or voltage is like a force; inductance is like mass; charge is like distance or displacement; current is like velocity; resistance is like damping; one over capacitance, 1/C, is like spring constant. Further, electromagnetic energy is analogous to kinetic energy; stored energy in a capacitor is analogous to potential energy stored in a compressed spring; time-rate of electrical energy loss is analogous to time-rate of frictional (damping) energy loss. The analogs tabulated symbolically are shown in the accompanying tabulation on page 98.

Equivalent two degrees of freedom systems are illustrated in figures 4 and 5. There the mutual coupling is elastance (capacitive). It is entirely possible to have either capacitive, inductive or resistive coupling or to have any combination thereof. The significant point to note here is that each degree-of-freedom of the mechanical system is analogous to a mesh of the electrical circuit, where a mesh is a circuit loop.

According to the well known formula, $v = f\lambda$; that is, velocity of propagation equals frequency of the wave times the wave length equals the constant 300×10^6 meters per second — it is easily ascertainable that electrical waves of a few centimeters to several meters in length may be readily obtained by VHF and UHF radio electrical systems. The ef-

(*Continued on page 96*)

Conductor vibration on transmission lines can be, and frequently is, a very serious matter. Recent failure of occasional spans of the Hoover Dam transmission line, from conductor vibration, caused considerable concern until the reason for the increased vibration was discovered. In this brief but interesting account of conductor vibration by Professor Nau, he defines the two types of conductor vibration and explains the basic similarity between mechanical and electrical vibrating systems. Also, he presents data on recently reported vibration trouble and discusses a number of methods for eliminating conductor vibration difficulties

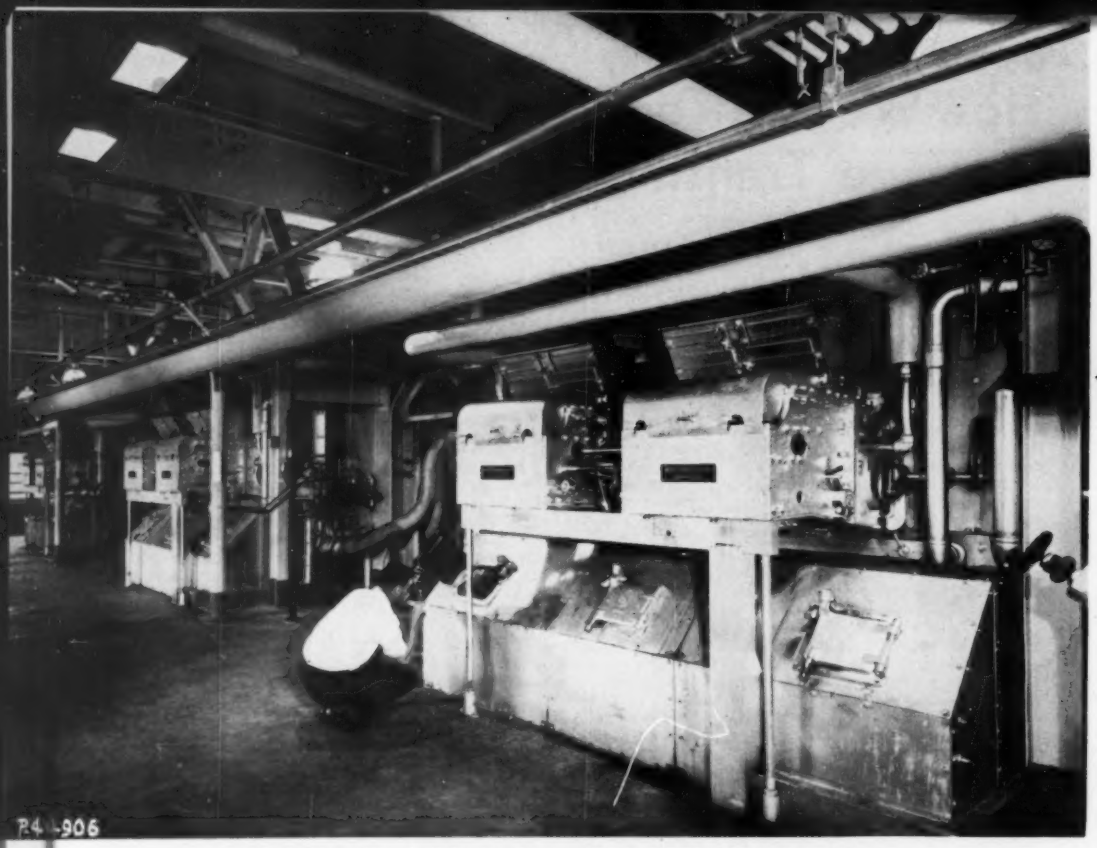


Fig. 1. General view on boiler operating floor, new Beloit steam plant of Fairbanks, Morse & Co.

Principal Power Plant Equipment

Boilers.....Combustion Engineering-Superheater, Inc.
Spreader Stokers (and accessories)
Westinghouse Electric Corp.
Fly Ash Collectors.....American Blower Corp.
Deaerating Feedwater Heater.....Elliott Co.
Automatic Coal Scales, Spouts and Distributors
Richardson Scale Co.
Boiler Feed Pump Equipment
Turbine Equipment Co. of N. E. (DeLaval pumps
Westinghouse turbine drive)
Water Treating Equipment.....Infilco Inc.
Induced-Draft Fans
American Blower Corp. (Westinghouse turbine drive)
Forced Draft Fans
Westinghouse Electric Corp., B. F. Sturtevant Div.
Condensate Pumps.....Fairbanks, Morse & Co.
Water Columns.....Diamond Power Specialty Corp.
Automatic Combustion Control, Boiler Feedwater Regulation, Flow and Temperature Instruments; Draft Gages
Republic Flow Meters Co.
Safety Valves.....Consolidated
Steel Stacks.....Otto Biefield & Co.
Coal-Handling Equipment.....Link-Belt Co.
Coal Crusher.....Jeffrey Mfg. Co., Ltd.
Ash-Handling Equipment.....United Conveyor Corp.
Phosphate Feed Equipment.....Milton Roy Co.
Piping.....S. J. Reynolds Co., Inc.
Soot Blowers.....Vulcan
Chain Hoist and Trolleys
Wright Mfg. Div., American Chain & Cable Co.
Laboratory Equipment.....Metalab Equipment Co.
Indoor Unit Substation.....Westinghouse Electric-Corp.
Lighting Panel.....Cutler-Hammer, Inc.
Control Air Compressor
Worthington Pump & Machy. Corp.
440-v Motor Controls
Lighting Cabinets
Starters and P.B. Stations.....Grainger-Rush Co.
Welded Steel Tanks.....Buffalo Tank Corp.
Transformers (dry type)
Small Air Circuit Breakers
Westinghouse Electric Supply Co.
Transformers (dry type).....Graybar Electric Co., Inc.
Blowoff Valves.....Edward Valves, Inc.
Sample Coolers.....Hagan Corp.
Relays and Switches.....Westinghouse; Grainger-Rush
Unit Heaters.....Trane Co.
Disconnect Switch.....Delta-Star Electric Co.
Structural Steel....Mississippi Valley Structural Steel Co.
Consulting Engineers..Stone & Webster Engineering Corp.

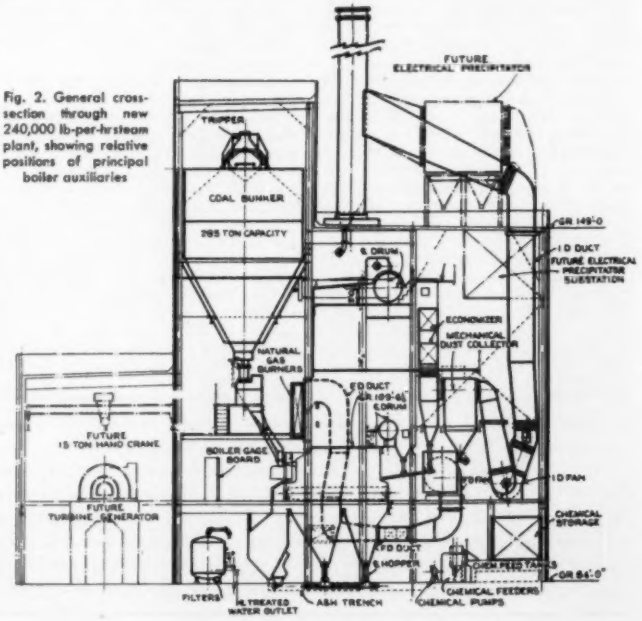


Fig. 2. General cross-section through new 240,000 lb-per-hr steam plant, showing relative positions of principal boiler auxiliaries

New Steam Plant Halves Labor, Cuts Fuel ⅓ for Fairbanks, Morse

THE NEW STEAM PLANT built by Fairbanks, Morse & Co. to serve its great factory at Beloit, Wisconsin, is shown in these illustrations. It was designed by Stone & Webster Engineering Corp. It can supply a total of 240,000 lb per hr of steam for process and heating and is placed near the existing Diesel engine plant that generates electricity for the factory. All units of the steam plant were in successful operation on March 15, 1951.

General design of the plant is shown in Fig. 2. The design provides for an extension to house future turbine generator units if required.

Boiler Details

The three boilers are 2-drum, bent-tube units, each of 80,000 lb per hr capacity, at 200 psi, 450 F, designed for firing either with coal or natural gas; combination gas and oil burners will permit future oil firing. Each boiler is equipped with forced and induced-draft fans and a mechanical type dust collector.

Boiler feedwater is natural well water treated by a hot-process lime-soda system, deaerated in a deaerating heater, with supplementary phosphate feed direct to boiler drums. Two turbine-driven and two motor-driven feed pumps are provided; induced-draft fans are turbine driven; thus there is a supply of turbine auxiliary exhaust steam available for feed heating.

Coal is received by rail, flows into the pocket under a trestle, then passes to a feeder that delivers it to belt conveyors, which discharge into a crusher. Thence the crushed coal is elevated by a bucket elevator to a conveyor to fill the bunker. From there it flows through the coal scales to the stoker hoppers.

Details of Firing Equipment

The boilers are fired by Centrafire spreader stokers of the traveling grate type. Each furnace is 9 ft 3 in. wide and 16 ft 2½ in. deep with 149.9 sq ft of active grate area.

Each stoker burns approximately 8000 lb of coal per hour at rated capacity, this quantity depending on type of fuel. The boilers are under complete automatic combustion control, which automatically adjusts fuel feed and air-flow according to steam demands.

This installation replaces six natural-draft chain-grate stokers. Under identical temperature and load conditions, the previous stokers burned approximately 50 per cent more coal than the new ones.

Operating Results and Savings

Advantages claimed for this new boiler plant are improved efficiencies through generation of more steam per pound of coal plus a labor saving of 50 per cent. Only half of the former operating staff is required. These new boilers and stokers provide greater ease of operation and flexibility due to the greater speed of response to changing steam loads than was possible with the former stokers. In addition, the hydraulic feeder mechanism and large displacement rams make it possible to feed wet coal.

The grate itself is hydraulically-driven through a speed range which provides infinite adjustment. A hydraulic motor-driven oil pump provides motive power for the entire stoker. Provision can be made for turbine drive.

T. M. Thorsen, chief engineer, power house, is in charge of the new plant.

Fig. 3. Exterior of new steam plant. Building has structural steel frame, with walls of insulated metal panels

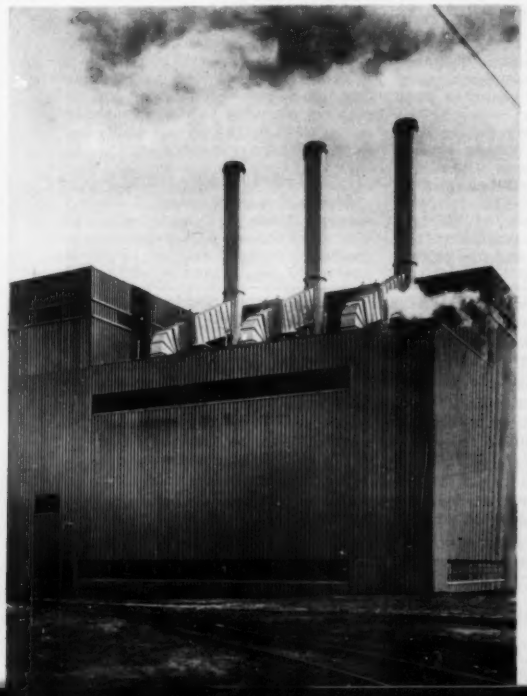


Fig. 4. View on main operating floor looking opposite from Fig. 1, showing location of boiler control panels and master panel opposite boiler fronts

How Pumped Storage Can Pay Off for You Today

Recent developments, like the new reversible pump turbine, help make pumped storage pay off nowadays under conditions where conventional hydro would not. . . . Pumped storage is like a storage battery. . . . Especially in fuel-electric systems, it makes possible the use of low-value off-peak power to store energy in form of water, which generates high-value hydro power for peak load periods. . . . Can be on large or small scale. . . . Improves load factor of fuel-burning plants. . . . Complete calculations for a specific example, with curves for estimating power and selecting units, details of site and types of units, transmission line, and costs. . . . Example shows how, with same dam and same water, pumped storage gives ⅓ more power at ⅓ the installed cost per kw of conventional hydro

By CHARLES H. SPINK
Hydraulic Engineer

PUMPED STORAGE is a term applied to a process whereby off-peak energy is employed to pump water from one reservoir or elevation to another reservoir of higher elevation, which subsequently discharges this water through a hydraulic turbine to generate power during times of maximum or on-peak demand. Thus the term "storage" is applied to water with a suitable head differential, so that it is, in a sense, stored electrical energy, the idea being to more fully utilize outside sources of energy that are idle during times of minimum load to make more power available during times of heavy demand.

Use of pumped storage for power will be found economical more often than is realized. It has a high efficiency and many advantages in a combined fuel and hydro power system. Besides the advantage of converting low value off-peak energy in a fuel-electric system into high value on-peak energy, it may have other advantages in location of project, utilization of inherent head, ability to vary plant capacity to provide more economical project and capability of utilizing a site on a stream of low average flow to supply a large block of peak power.

All these factors are discussed in detail in a 12-page article by the author, of which this is a brief abstract. A specific pumped storage project is calculated and full economic data are presented to show how the overall cost per kilowatt of installed capacity of pumped storage can be reduced about ¼ of the cost of that of a conventional hydro plant.

This study is based on the assumption of a pumped storage hydroelectric development supposedly constructed by the private utility industry with private funds.

Types and Designs

Most active development of pumped storage power has taken place in Europe. Total world horsepower capacity in pumped storage plants is now over 1,500,000 and about 825,000

THIS IS an abstract of a detailed engineering study prepared especially for POWER ENGINEERING by one of the leading hydraulic engineers in the field. We are reprinting the complete study as a 12-PAGE SPECIAL SECTION and will send you a copy free on request.

It is packed with the most practical and usable data on pump-turbine units; calculations of water flow, turbine and pump capacities, output; curves of turbine and pump relationships; transmission line data; and definite figures on what it all costs.

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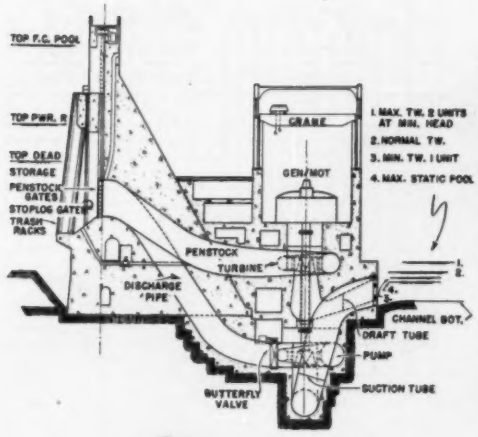

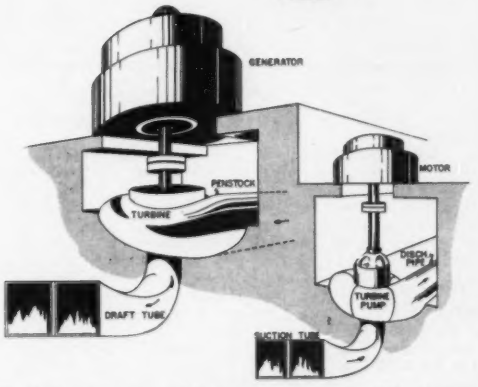

Fig. 3. Common arrangement for pumped storage, with individual units: a conventional hydroelectric generating unit and a separate motor-driven pump

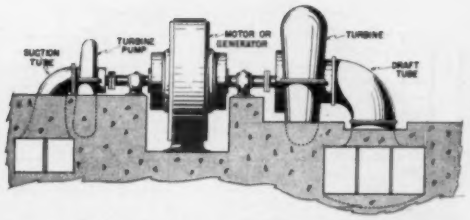

Fig. 2. Horizontal-duplex pumped storage unit, with generator/motor in middle, hydraulic turbine on one end of shaft, pump on the other

Fig. 1. (Left) Typical vertical-tandem unit as installed for pumped storage developments. Generator/motor, hydraulic turbine, and pump, all in tandem on one vertical shaft

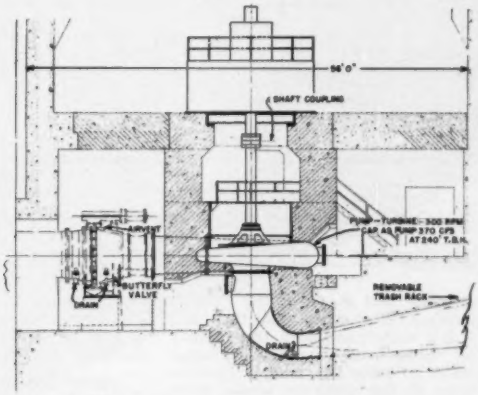

Fig. 4. Latest form of pumped storage unit: a vertical single-runner, single-speed reversible Francis type unit, with a generator/motor. Rotates in one direction, with motor driving it as a pump, using off-peak power to pump water into a reservoir. At peak-load periods, water from reservoir runs back through runner, driving it in opposite rotation as turbine-generating unit. Wicket gates in discharge passages help match pump and turbine characteristics

hp in pumps. The United States has lagged far behind the rest of the great industrial countries of the world in this development. At present there are only three operating pumped storage plants in this country.

Types and designs of existing projects are extremely varied. They include projects where the water is obtained from natural flow of a stream augmented by pumped water, and plants where all the water is pumped. They also vary from large dams and reservoirs to small dams with only enough storage for one day's operation.

The power generating and pumping equipment installed in these projects is even more distinctive and varied than the dams and reservoirs. It includes four fundamental types, as shown in Figs. 1, 2, 3 and 4. The fourth type of unit, Fig. 4, and the one that has the best prospect of gaining popularity in this country is the vertical, Francis-type, single-speed, reversible pump turbine. This has recently been developed by Allis-Chalmers Mfg. Co. which held an Engineers Conference on June 1, 1950, as reported in POWER ENGINEERING, July 1950, at which the tests and results of their research and experimentation with this reversible pump turbine were displayed.

Differing from the site for a conventional hydro plant, the site for a pumped storage hydroelectric plant may be located on or near any stream where enough head can be developed and where there is enough flow to make up evaporation and leakage losses. The power plant can be constructed across the stream or parallel to it as shown in the headpiece of this article. Its capacity would depend upon the amount of pumping water available and the characteristics of the load. It must, of course, have a proper supply of water available below the power house for pumping and the article discusses the use of over-lapping reservoirs on the location.

Another important factor is the

THE AUTHOR

CHARLES H. SPINK at present is Senior Hydraulic Engineer in the Fort Worth, Texas Regional Office of the Federal Power Commission, and specializes in hydroelectric power planning. The last 16 years of his nearly 45 years of experience have been with the Federal Government. He has seen rapid progress in the power industry, especially in hydroelectric power, with which he is most familiar. He has been interested in pumped storage for many years, but it was not until the last few years that he has given it serious thought and study. It was largely his co-operative effort with Allis-Chalmers Manufacturing Co. that led to the model tests of the first single-speed, Francis-type, vertical, reversible pumped storage unit to be designed and built in this country. The model and its test were displayed at the Engineers Conference held in their plant on June 1, 1950. The data and opinions expressed in this article are those of the author and not necessarily those of the Federal Power Commission.

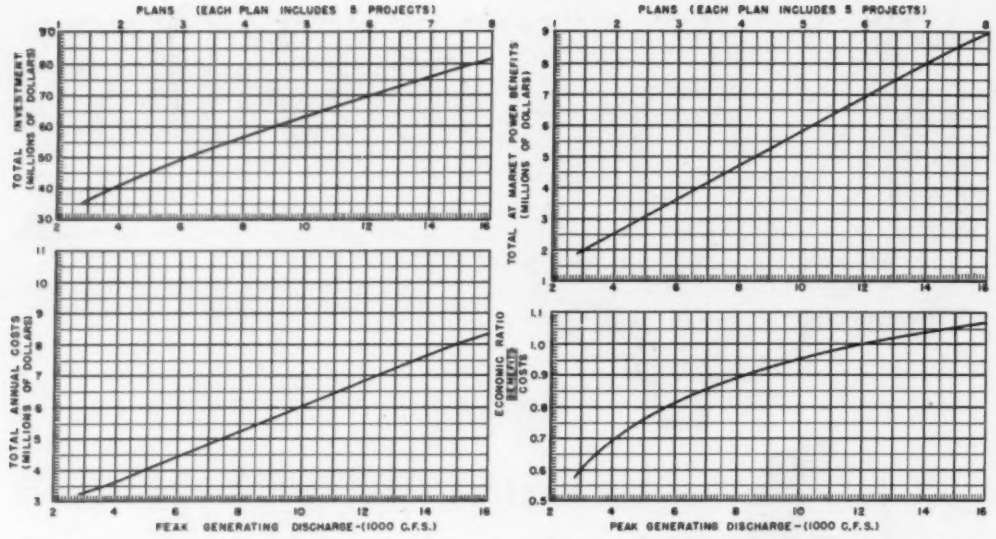
PLANS (EACH PLAN INCLUDES 5 PROJECTS)
TOTAL INVESTMENT (MILLIONS OF DOLLARS)
PLANS (EACH PLAN INCLUDES 5 PROJECTS)
TOTAL AT MARKET POWER BENEFITS (MILLIONS OF DOLLARS)
TOTAL ANNUAL COSTS (MILLIONS OF DOLLARS)
ECONOMIC RATIO BENEFITS COSTS
PEAK GENERATING DISCHARGE-(1000 C.F.S.)
PEAK GENERATING DISCHARGE-(1000 C.F.S.)

Fig. 5. Graphic economic analysis of pumped storage development described in text covers 5 projects, each with 8 plans. Assumed to be carried out by private utility using private capital

Upper left:—At-market investment includes transmission lines and substations as well as at-site projects. Lower left:—Includes interest, retirement, taxes, insurance, O & M, administrative expense, purchase of off-peak energy. Upper right:—Includes value of capacity and energy at market. All these data must be taken into account in calculations

capacity and shape of the channel forming the afterbay or suction pool. If it is narrow and deep, trouble may be encountered in securing enough water to serve the pumps. Illustrations in the complete article show various shapes of suction pools and their effect on usable water for pumping.

Selection of types of units is extremely important. It now appears that the reversible pump turbine unit of the single-speed, vertical, Francis type may best suit the needs in this country. The Allis-Chalmers' tests indicate a best turbine efficiency of 87 per cent at 9450 hp, 87 ft head and 163.6 rpm, while the pump performance showed best efficiency of 88 per cent at 1150 cfs, 63 ft head, 163.6 rpm.

Calculation of an Example

To illustrate more clearly the features of design and operation for pumped storage projects in a fairly large interconnected hydro and steam system, a specific example is calculated in the complete article. This involves consideration of 5 different projects, in each of which 8 plans of design were studied. A load duration curve projected for the year 1970, on the basis of present available data, is shown in the article, and one of the projects, called Project E, was selected for calculation. In this project, Plan 1 for a conventional hydroelectric development and Plan 8 for a development including pumped storage units are compared. The total water discharge is 16,000 cfs daily at certain assumed load factors. The total dependable capacity in 4 reversible units is 43,162 kw and in two conventional units is 40,948 kw, a total of 84,560 kw. Diameters of the penstocks are calculated.

Load Characteristics and Transmission Line

Detailed study of the load characteristics of these projects is next presented, including a tabulation of the amount and critical year characteristics of the various projects.

After analyzing the various transmission losses and other losses in the system, the hydroelectric capacity of 443,350 kw of dependable hydroelectric capacity from all projects in the system was placed on the peak of the August 1970 load curve, leaving 1,296,650 kw to be supplied by existing and new fuel electric capacity. The hydraulic studies indicate a pumping capacity requirement of 324,760 kw at the various projects. This would require about 345,000 kw of off-peak fuel electric pumping capacity after accounting for transmission losses. The off-peak energy for pumping would, if fully utilized, amount to about 108,000,000 kwh in August.

Next point taken up is the transmission of the power. The entire cost of the transmission system, however, could not be reasonably charged against the hydro plants because certain costs would also be incurred in supplying the same future loads from alternative steam electric plants.

The transmission system would consist of a new main high-voltage backbone interconnecting the hydroelectric projects with each other and with principal load and generation centers, not only in the river basin but also in adjacent parts of the selected power market area. No new lines would be included for interconnection with systems outside the market area.

Although the hydroelectric projects at five of the sites would be equipped with pumped storage facilities, it is found that no addtional facilities would be required expressly because of the pumping power requirements. The transmission system design is, of course, not conclusive, for it has not had the benefit of a calculating board study. But it is believed to be reasonable.

What Would It Cost?

Now what would all this cost? Estimated total investment would be $80,137,087 and total annual costs, including purchase of off-peak energy at 1.50 mills, would be $8,358,471.

In evaluating the benefits from the hydroelectric power at the projects studied, a value of $24.70 per kw for dependable capacity was determined and 1.05 mills for the average annual energy at the market or load centers. On this basis the total benefits would be $8,932,750. The economic ratio of benefits to cost would be 1.069 to 1.0, indicating that these projects would be slightly better than equivalent steam at the market or load center.

To recoup only the average annual cost, the energy would have to be sold for 11.59 mills per kwh.

By way of comparison between the conventional plants under Plan 1 and the pumped storage development

(*Continued on page 122*)

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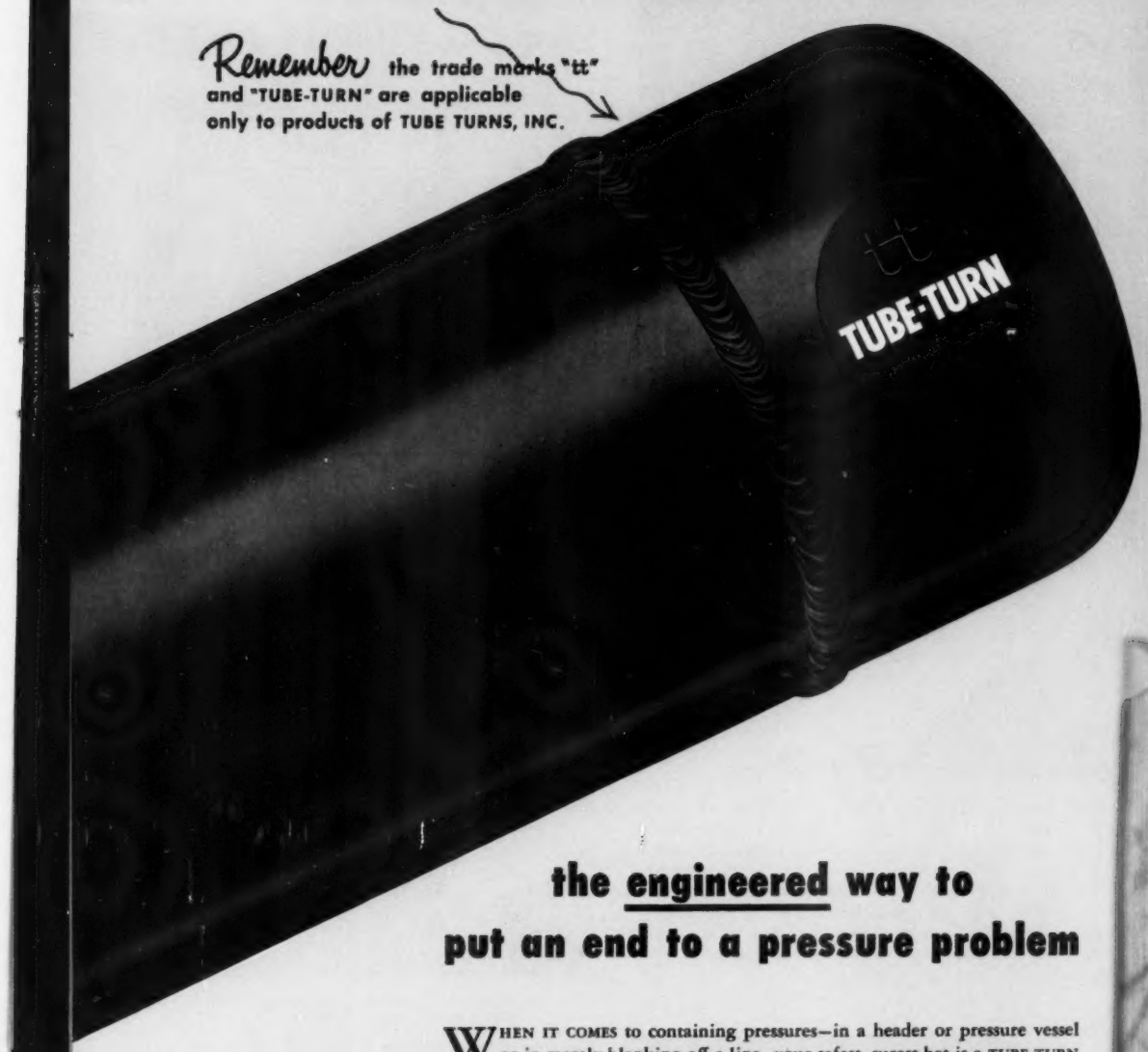

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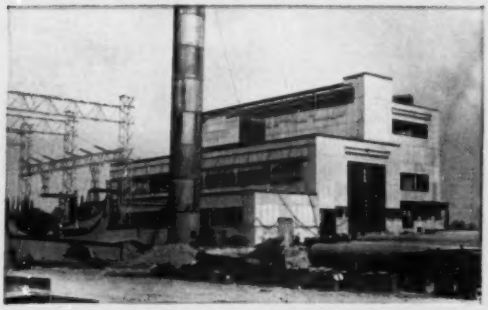
New Ford Power Plant features welded piping



Power station for Ford Motor Company's giant new engine plant and foundry, now being built in Cleveland; F. A. Fairbrother —Geo. H. Miehls, Architect and Engineer; Albert Kahn Associates, Consultants. Engine plant will be equipped with the last word in automatic machinery—to save production man-hours. The designers believe in saving maintenance man-hours too. Thus at the power plant, which will supply 360,000 pounds of 150-lb. steam per hour for heating and process, an all-welded piping system with TUBE-TURN Welding Fittings and Flanges was specified. Welded steam, air, and condensate lines are permanent and leakproof.

Here the 18" steam main from the power plant leads to a fabricated "Y" connection, then through tunnels to foundry and engine shop. One side is stepped down through a TUBE-TURN Welding Reducer to a 16" line; the other side through another TUBE-TURN Welding Reducer to a 12" line. Special "Y" connection was made by cutting and welding two 45° Welding Elbows, a job that calls for uniform wall thickness and concentricity throughout the fittings—a point of pride with TUBE TURNS, INC.

In engine shop, smaller lines designed to carry coolant oil to machine tools are also welded. Wide range of TUBE-TURN Welding Fittings and Flanges—including more than 4000 different items—simplifies installation job. Leak-proof piping will free maintenance personnel for other work.

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Preferably you should be a man 25 to 35 years old, with a Bachelor's degree in mechanical or electrical engineering. Degree or not, you should have at least 2 or 3 years' practical work in industry, handling (or very familiar with) boilers and firing equipment, turbine generators, auxiliaries, and in touch with general power house design, operation and maintenance. Emphasis of your experience should be on steam engineering, although you must also know something of electrical work.

Combined with this, you should have some writing ability and show evidence of aptitude for technical editorial work.

The background outlined is even more important than formal academic training or degrees.

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Fig. 1. Looking into laboratory. This laboratory is no cut-and-dried affair but a gradual development and improvement from ideas contributed by the power plant personnel

Testing Equipment

10 — 25 ml Automatic Burettes (Betz)
3 — 250 ml Casseroles
3 — 145 ml Casseroles
8 — 250 ml Erlenmeyer Flasks
1 — Thermometer (0–220 F)
1 — Winkler Oxygen Testing Kit — complete
1 — Paconometer and Test Tube
1 — Taylor Water Analyzer with slide for total iron
1 — Taylor Water Comparator with slides for phosphate, pH and sodium chromate
6 each — 10 ml — 25 ml — 50 ml — 100 ml graduated test tubes
6 — 0.05 ml Droppers
6 — 1 ml Droppers
Glass Funnels — various sizes
No. 5 Whatman filter papers — 12.5 cm
No. 2 Whatman filter papers — 32.0 cm
1 — Electric 2-Burner Heater.

Equipment and chemicals purchased from various supply houses such as W. H. & L. D. Betz, W. A. Taylor & Co., Allis-Chalmers Mfg. Co. and others, as required. Cost of above equipment about $300

By ARTHUR BAUMANN, Sr.
Chief Engineer, Power Plant
Chevrolet Transmission
Saginaw, Mich.

The Operating Staff Developed This Power Plant Laboratory

THE LABORATORY shown here was developed for making all necessary water tests in a 3-boiler, 300,000-lb-per-hr steam plant — typical of many medium-sized plants. Compare it with those shown in A Power Plant Laboratory, by S. M. Sperry, April, 1951 issue and Another Power Plant Laboratory, by Donald Rushmore, June, 1951 issue.

Details of the laboratory are self-evident from the drawings. However, the arrangement of equipment presents some unusual features.

Ten automatic burettes are placed along the East wall, Fig. 7, and mounted in fixed positions. A track is located slightly in front of and above the burettes, along which rolls a gage-column magnifying glass. Accurate readings are thus obtained from the burettes with a minimum of effort. Likewise, on the West wall, Fig. 5, a soda-ash chart and a lime chart are mounted on wheels so they are free to roll along a stationary track (detail in Fig. 6). Each chart can be rolled back and forth behind a fixed vertical scale so that hardness and alkalinity data can be easily read. The charts are faced with lucite to give a clean permanent finish.

Water samples are taken by means of the equipment of Fig. 2. A daily water treatment log, Fig. 3, is kept of results obtained in the laboratory. On this log, entries can be made, every four hours if necessary, of the various tests performed. Water from the softener and boiler water are given the tests shown in the table. Testing is split among the three shifts and rotated each month. Shift engineer does testing and adjusts feeds.

The power plant itself is a three-boiler plant, producing 300,000 lb of steam per hour. The plant is equipped with a lime-and-soda-ash hot-process softener, filters, and associated pumps and equipment.

The men responsible for water testing, treating and adjusting have recently completed an extension course on Industrial Water Treating and Analysis, under the instruction of Professor M. Obert, given locally by Michigan State College.

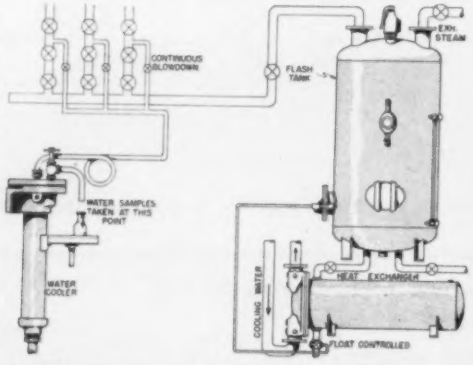


Fig. 2. Just outside water testing laboratory, this water sampling equipment is connected directly to the continuous blowdown system from the three boilers, independent of mud-drum blowdown

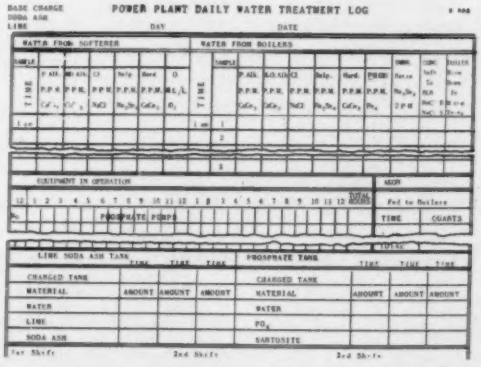


Fig. 3. This daily water treatment log is carefully kept, entries being made each shift as specified. Last column records micro-turns on blowdown valves, controlled manually, depending on boiler water total solids and alkalinity

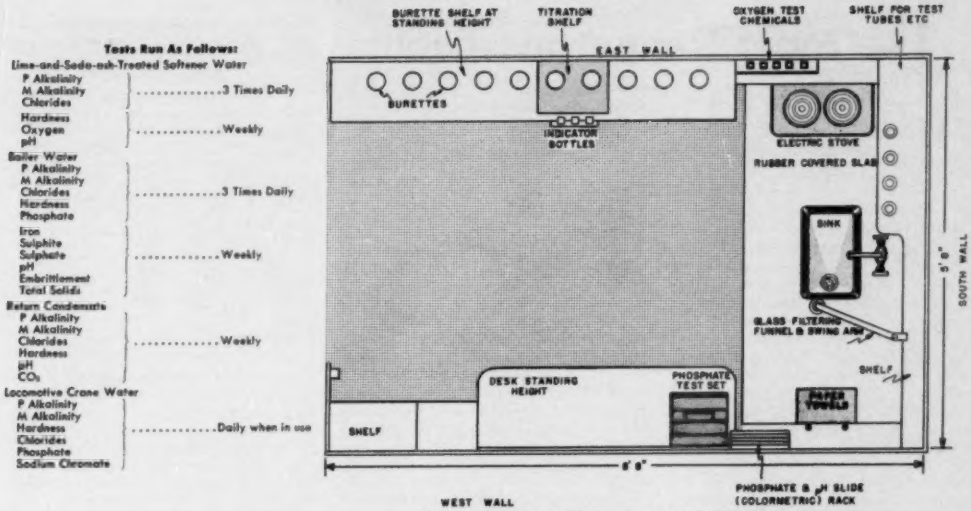


Fig. 4. General plan of laboratory for 300,000-lb-per-hr steam plant

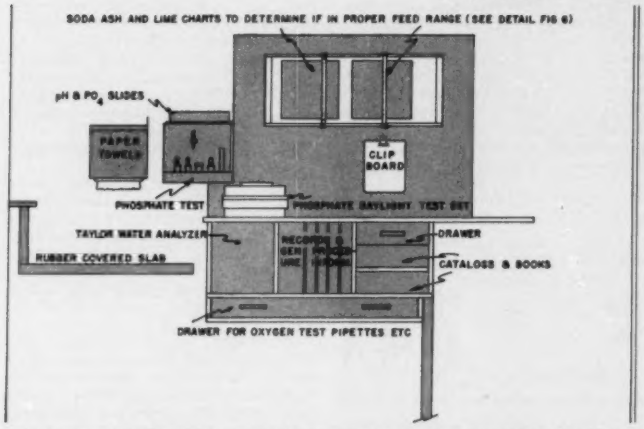

SODA ASH AND LIME CHARTS TO DETERMINE IF IN PROPER FEED RANGE (SEE DETAIL FIG 6)
pH & PO4 SLIDES
PAPER TOWELS
CLIP BOARD
PHOSPHATE TEST
PHOSPHATE DAYLIGHT TEST SET
TAYLOR WATER ANALYZER
DRAWER
RUBBER COVERED SLAB
CATALOGS & BOOKS
DRAWER FOR OXYGEN TEST PIPETTES ETC

Fig. 5. Elevation of laboratory West wall. The feature here is the convenient set-up for reading soda-ash and lime charts quickly and accurately. See detail in Fig. 6

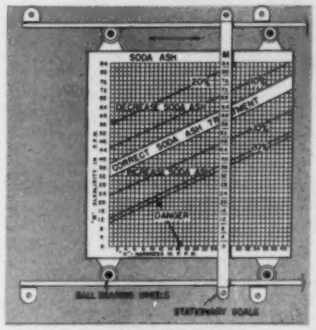


Fig. 6. Detail of mounting of the soda-ash chart. Lime chart similarly mounted. Charts are enlarged copies furnished by Allis-Chalmers Mfg. Co. for control of the hot-process soda-ash and lime water softener. Charts mounted on board and covered with lucite to keep them clean

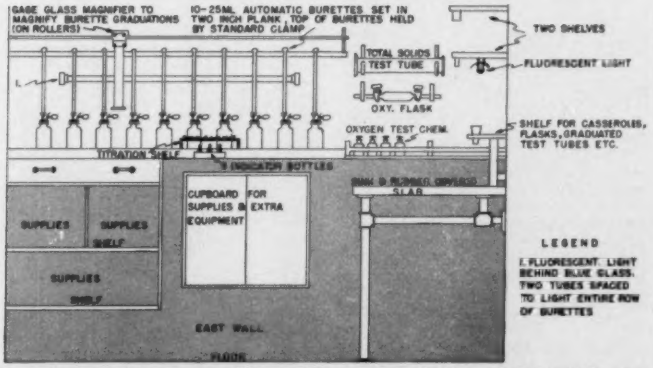

GAGE GLASS MAGNIFIER TO MAGNIFY BURETTE GRADUATIONS (ON ROLLERS)
10-25ML AUTOMATIC BURETTES SET IN TWO INCH PLANK, TOP OF BURETTES HELD BY STANDARD CLAMP
TWO SHELVES
TOTAL SOLIDS TEST TUBE
FLUORESCENT LIGHT
OXY. FLASK
SHELF FOR CASSEROLES, FLASKS, GRADUATED TEST TUBES ETC.
OXYGEN TEST CHEM.
TITRATION SHELF
9 INDICATOR BOTTLES
SINK & RUBBER COVERED SLAB
CUPBOARD FOR SUPPLIES & EXTRA EQUIPMENT
SUPPLIES
SUPPLIES
SHELF
SUPPLIES
SHELF
EAST WALL
FLOOR
LEGEND
1. FLUORESCENT LIGHT BEHIND BLUE GLASS. TWO TUBES SPACED TO LIGHT ENTIRE ROW OF BURETTES

Fig. 7. Arrangement of equipment on laboratory East wall. Burette shelf is wood covered with Transite, shellaced and varnished. Shelves and desk top of wood. Feature here is magnifying glass, taken out of Reliance mica-sight periscope-type water column. It rolls along on a rail in front of the burette scales and aids accurate scale reading

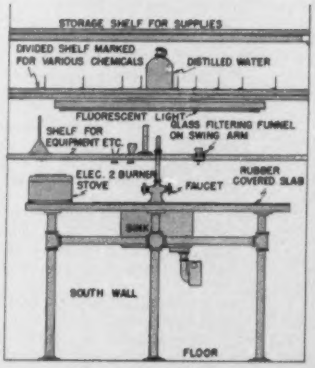


Fig. 8. Elevation of laboratory South wall. Sink table top is slate, covered with rubber. This aids in preventing chipping and breakage of glassware

The Most Dangerous Tool

Oscar the Gas Works Owl's Penetrating Observation on the Most Dangerous Tool anywhere comes as an Anti-climax; nevertheless the story has a Happy Ending

By JOHN RAVEN

WE HAD SO MUCH TROUBLE with our welding lately, and especially with a new 16-inch gas line through the booster house, that one morning I came to work wondering if I oughtn't to quit before I got fired anyway. Actually there was something funny about that new line. We just couldn't keep a couple of butt welds from opening up, and finally we had to weld a strap around each one for extra strength. So far the line had held for two days and we had it in service, but this morning I felt too nervous to look at it. One more break and the Boss would chase me clear to Timbuctoo or behind the Iron Curtain, whichever was farther. As I came into the office, the signals were all bad.

"John," bellowed the Boss. "Come here."

I figured the line had failed and the axe was falling, but he waved a paper under my nose and I saw it was the monthly accident report from the safety engineer.

"Five accidents!" he yelled with each of his three chins clapping approval to every word, "and you're to blame! You hear?"

"Me?" I gulped. "I thought it was O'Gee's job to look after safety."

The Boss put his big fat head between his big fat hands and groaned.

"What, I ask you," he said, "can a safety engineer do with the morons, freaks and invalids we've got around this works? Every one of them gives the same excuse for his accident. He's sick, or crippled or dizzy and shouldn't really be working. Don't you know such people are a menace? O'Gee told me all about that human boomerang you got in the booster house. What's he doing there?"

"If you mean Unhappy Hooligan," I said, "It's only recently he walks bent over. It's lumbago. He'll get over it."

"Not in my works," yelled the Boss. "Fire him. Today. And that monstrosity in Boiler House No. 3, — the one with two heads. Get rid of him."

"It just looks like two heads," I corrected him promptly. "He's an amateur magician. He does it with mirrors. And he's the best fireman we've got."

The Boss turned half around and glared toward the corner behind me.

"O'Gee," he demanded of a pair of wasp-tailed mustaches attached to a small figure huddled in a chair, "Did you or did you not see a man with two heads?"

"Well Boss," said the safety engineer coming to life, "It looked like two heads. But more important right now is your health. I'm a new man in the works, but I see already you must calm yourself. Your color is high. Do strokes run in your family, sir?"

The Boss backed up with his three chins flapping, and I could see he was startled and no little scared, the big baby.

"They do, O'Gee. How does one start?"

"With a red face, a headache, a very slight one of course, and some emotional upset. You look quite vulnerable sir, in your present mood."

The Boss sat down and wiped his red face.

"Gentlemen," he said tragically, "you and your accidents have brought me to the verge of a stroke, perhaps death. But will I let this appalling prospect get me down? No."

He arose majestically behind his

"Five accidents! And You're to blame! You Hear?"

executive's desk and pointed to the door in the best Hollywood form.

"Out of my sight," he cried, obviously more in anger than in sorrow. "Both of you. And don't come back until you, O'Gee, inspect every dangerous tool in this works and make it safe. And John, if you leave a freak, boomerang or bellyache alive until tomorrow morning, you're fired. Understand? Now go!"

I went to my office the way a dog creeps home after being licked in a fight, and O'Gee followed me.

"This is terrible," said O'Gee wiggling his wasp-tailed mustache sympathetically, "at least for you. Tsk, tsk. You look unwell, too, John. Bad color. Your health may keep you from getting another job."

"I'm not fired yet," I said irritably.

"But you will be," O'Gee nodded with conviction. "You're anemic in the guts, John. You haven't the guts to fire anybody to save yourself."

"No," I said mad enough to choke at the spot I was in. "But I'm not afraid to fire a guy that needs firing. Maybe we've got a few of 'em around here at that."

"I didn't dare read it with O'Gee looking on"

There was a note on my desk in the familiar hen-scratchings of Oscar the Gas Works Owl, but I didn't dare read it with O'Gee looking on. He'd be only too happy to tell the Boss I was cahooting with a hooter. So I shoved it into my pocket and stood up.

"Suppose," I said grimly, "you show me the two-headed man the Boss wants fired. I'll start on him."

"Well now," said O'Gee hesitatingly, "I could be a little mistaken about the two heads. Maybe you better start with Unhappy Hooligan. And when he is finished, — here, — let me look at my list."

He pulled out a notebook and wiggled his wasp-tails over it.

"Here's Honest Melarkey. Ever since he fell off the dock and stopped up the condenser intake he's got a muddy color. Next, take Jingles Joe. I've heard him belch several times. He should get an X-ray of the stomach. Then Dignified Willie is suffering from creeping pains that itch at night. In Boiler House No. 1, —"

"O'Gee," I yelled," the gas works is in appalling condition, but your business is to worry about tools. I'll worry about the people. Maybe if you paid more attention to tools we'd have fewer accidents."

I stamped out of the office and almost fell over Old Joe the Timekeeper.

"John," said Old Joe, "excuse me. I been in the works 40 years and lately I been havin' dizzy spells. I don't see people sometimes. Mr. O'Gee thinks its somethin' in my head. I'm a-goin' to the doc right now."

O'Gee looked over my shoulder and commented approvingly:

"Better hurry, Old Joe. Time can run out awful fast with head troubles."

I began to wonder if maybe I wasn't sick too, and maybe all my welders had spots before their eyes which was the reason for my pipe welds failing. I decided to go ask them, but changed my mind when O'Gee said emphatically:

"You see how important it is to act fast? By tomorrow for instance, Old Joe could be dead. Or Unhappy Hooligan might kill himself and wreck

the works. You've got to step in, John. It's tough, but necessary."

I didn't want to fire Unhappy Hooligan just because he had lumbago, and besides he had 14 children to support. But not firing him would be sure to get me fired and wouldn't save him anyway. So I headed reluctantly to the gas booster house.

When we got there, the gas booster pumps were thumping away, the test

"—slapped it tightly over the open seam"

flame was burning brightly in a corner of the room, and Unhappy Hooligan was presiding over all this activity while bent down like a boomerang sure enough.

"John," he mourned in his most unhappy voice, "I feel terrible. Mr. O'Gee gimme a plaster for my lumbago but so far it ain't done me no good. You know any cures?"

I felt a pang of conscience but opened up on him bravely.

"Unhappy Hooligan," I began, "what I'm about to say is certainly tough, but when the safety of the gas works is concerned —"

And right there I stopped, because over his head a welded seam in my new 16-inch gas line, which passed through the booster house, was opening up before my eyes. It didn't tear violently, or burst, it just acted as if the weld was tired of holding my pipes together and had decided to let go calmly and quietly. Brown gas came pouring out of the rupture and tumbled straight toward the open test flame, while I just stared at it, feeling frozen all over.

O'Gee saw what was coming and let out a fire-siren sort of howl, after which he went out the door faster than any fire engine I ever saw. That yell unfroze me, and I ran to the gas burner to turn off the flame, but tripped over a valve wheel and fell flat. Meanwhile, Unhappy Hooligan calmly pulled the lumbago plaster off his back and reaching upward, slapped it tightly over the open seam, where it stopped the gas leak immediately and completely.

As I got up he regarded me in his usual sorrowful manner.

"John," he said, "that plaster cost me 75¢ which I paid Mr. O'Gee, and I think the gas works oughta gimme either 75¢ or a new plaster. An' John, I'm tellin' you now, you been brickin' up too tight around that gas pipe where it goes through the buildin' walls. That's why the weld busted, it ain't got no rightful chance to expand. Now what was you sayin' when you come in?"

"What I was saying doesn't matter," I said, "What does matter is that in my book, you're something of a hero, Unhappy Hooligan. And I'm going to tell the Boss about it. Right now."

Unhappy Hooligan straightened up and for the first time in years, I saw him smile.

"John," he said, "my back don't hurt no more. And tell the Big Bushwah I liked savin' the gas works. Tell him it was a pleasure."

On my way back to the office I remembered Oscar's note and dug it out of my pocket. Here is what I read:

njuneers (wrote Oscar) shud never 4get that safety is up 2 each man n also that the most danjerus tool anywhere is th human tongue yur frend oscar th gas works oul hoo es all n nos all

I started to tear up the note, then changed my mind. This time I decided, thinking of Honest Melarkey, Old Joe, Unhappy Hooligan, the Boss and all those others who had been feeling bad since O'Gee was in the works, I'd make a legible copy and give it to O'Gee after I told him he was fired. He could think it over while hunting a new job.

CONDENSER LINED WITH NEOPRENE

DURING a recent overhaul of the No. 1 turbine at the Cahokia plant, it was found that the condenser tubes were seriously eroded at their inlet ends, evidently from the abrasive material carried by the condensing water.

In the condenser, the suspended material in the circulating water striking the hard material of the tube or tube sheet actually grinds away the metal. If, on the other hand, a resilient material, such as rubber, is interposed, the energy in the particles suspended in the water is absorbed in the cushion of the rubber coating and rebounds without any serious injury to the rubber coating.

A coating of Neoprene is sprayed into tube inlets to prevent excessive wear

After considerable investigation, says *Union Electric* News, it was decided that a coating of Neoprene base rubber compound applied to the tube sheets and the inlet ends of the condenser tubes might solve the problem.

The ends of the tubes and tube sheets were cleaned by wire brushing and by sand blasting. Two coats of primer and about 8 coats of synthetic rubber were then applied by the usual spray gun method. If successful, the new method will provide an inexpensive and simple way of prolonging condenser life.

DIESEL ENGINEERS AT TEXAS SCHOOL

EXPLORATION OF RESEARCH in progress, and lectures covering the most recent information in the field of Diesel fuels and lubriants, highlighted the third Diesel Engine Manufacturers Association school at The Texas Co., Beacon (N. Y.) Laboratories June 25–29. University and college professors and instructors, all of whom are specialists in Diesel engineering, attended the Texaco school which is sponsored by the DEMA as a part of that organization's educational program.

During the five-day program research engineers from the Beacon Laboratories and the New York offices of The Texas Co. participated in the lectures and demonstrations. Motion pictures of laboratory and field research and first-hand examination of Texaco's extensive Diesel research projects augmented classroom work. The visiting educators, limited to fifteen in number by the special nature of the course, also had the opportunity of working with test equipment and new test methods which attract their special interest.

D. E.'S NEW ST. CLAIR PLANT

UNITED ENGINEERS & CONSTRUCTORS, with headquarters in Philadelphia, have been retained by Detroit Edison to construct their St. Clair Power Plant. This plant is located on the St. Clair River, about midway between St. Clair and Marine City.

The work by United Engineers & Constructors will be done from plans and specifications of Detroit Edison and is to start at once. The foundations are already being put in for the plant which will consist of three 125,000-kw turbine generators and three high-pressure boilers. Each boiler will have a capacity of 1,050,000 lb of steam per hr. The operation of the first turbine generator is scheduled for early 1953.

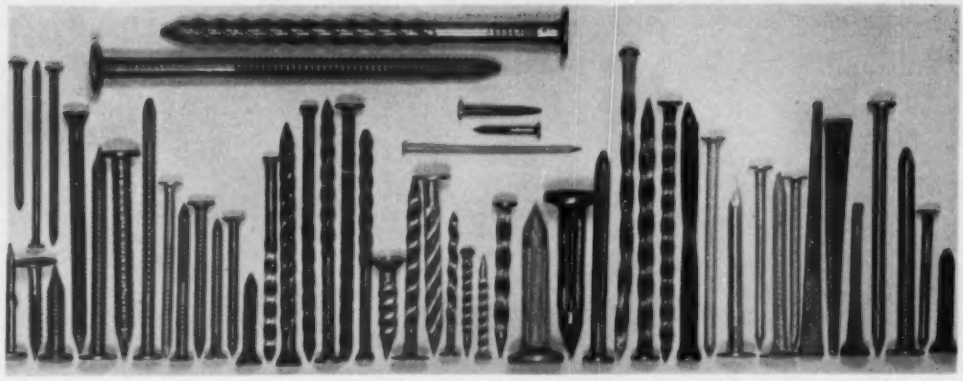


Fig. 1. A collection of nails showing various types of nail shanks

Recent Improvements in Nails and Nailing

Data on the effectiveness of Grooved Nails, obtained in investigations made at the Wood Research Laboratory of the Virginia Polytechnic Institute, compared with plain shank

By E. GEORGE STERN

Director, Wood Research Laboratory, Virginia Polytechnic Institute

GEORGE STERN'S article on the technical properties of the nail in the July issue met with considerable response from readers for data concerning the holding power of the grooved type of nail, which received only brief mention in that article. Accordingly, we now present further material from Dr. Stern's paper which gives comparative data on the effectiveness of helically and annularly grooved nails and plain shank nails.

Properly grooved nails provide radical increases in nail-holding properties. They are of considerable benefit in numerous nail applications for which optimum nail-holding properties are principal considerations or prime prerequisites. They may speed up and improve construction and assembly. Thus, their use may be of considerable economic advantage. Typical comparative data on the effectiveness of helically grooved *Screwtite*[1] and annularly grooved *Stronghold*[1] nails, in comparison with plain-shank nails, (a) immediately after driving and (b) after several months' seasoning of the wood, are presented in the tabulation of percentage values given directly at the left.

The above test values on the delayed withdrawal resistance in air-dry Southern pine increased to 1235 per cent and 973 per cent for 2-in. long, 0.120-in. wire-diameter, hardened, high-carbon-steel, helically grooved *Screwtite* and annularly

Comparison of Effectiveness of Low-Carbon-Steel, Diamond-Point, 2½-in. Long x 0.135-in. Diam. Plain-Shank, Helically Grooved *Screwtite*, and Annularly Grooved *Stronghold* Nails[1] On Basis of Comparison with Respective Plain-Shank Nail

Wood Species	Driven When	Tested When	Property	Plain-Shank Nail Per cent	Helically Grooved Screwtite Nail Per cent	Annularly Grooved Stronghold Nail Per cent
White Oak	Green	Green	Withdrawal Resistance	100	161	183
			Lateral Load-Carrying Capacity	100	114	85
Beech	Green	Green	Withdrawal Resistance	100	136	152
			Lateral Load-Carrying Capacity	100	136	180
Southern Pine	Part. Air-Dry	Part. Air-Dry	Withdrawal Resistance	100	125	244
			Lateral Load-Carrying Capacity	100	150	124
White Oak	Green	Air-Dry	Delayed Withdrawal Resistance	100	228	245
			Delayed Lateral Load-Carrying Capacity	100	134	114
Beech	Green	Air-Dry	Delayed Withdrawal Resistance	100	330	258
			Delayed Lateral Load-Carrying Capacity	100	150	127
Southern Pine	Part. Air-Dry	Air-Dry	Delayed Withdrawal Resistance	100	290	681
			Delayed Lateral Load-Carrying Capacity	100	176	140

[1] Trade name of products of the Independent Nail & Packing Company of Bridgewater, Mass.

Average Relative Efficiencies of Grooved Nails Over Plain-Shank Nails During Delayed Withdrawal Compared with Those During Withdrawal Immediately After Driving

According to Ratio (Delayed Withdrawal for Grooved Nail / Delayed Withdrawal for Plain-Shank Nail) / (Temporary Withdrawal for Grooved Nail / Temporary Withdrawal for Plain-Shank Nail)

Wood Species	Plain-Shank Nail	Non-Hardened Low-Carbon-Steel Helically Grooved Screwtite Nail		Hardened High-Carbon-Steel Helically Grooved Screwtite Nail		Non-Hardened Low-Carbon-Steel Annularly Grooved Stronghold Nail		Hardened High-Carbon-Steel Annularly Grooved Stronghold Nail	
White Oak	100%	(217/139)	156%	(200/134)	149%	(228/172)	133%	(200/130)	154%
Beech	100%	(359/117)	307%	(219/116)	189%	(310/127)	244%	(158/112)	141%
Southern Pine	100%	(443/134)	331%	(574/143)	401%	(857/150)	571%	(392/145)	270%
Weighted Aver.	100%	(284/128)	222%	(252/130)	194%	(313/169)	185%	(207/127)	263%

grooved *Stronghold* nails and to 1222 per cent and 772 per cent for 2½-in. long, 0.120-in. wire-diameter, hardened, high-carbon-steel, helically grooved *Screwtite* and annularly grooved *Stronghold* nails, respectively.

The statement made in the Wood Handbook that certain grooved nails, when driven into green wood, retain most of their original holding power during seasoning was verified by recent tests. Thus, the efficiencies of grooved nails, in comparison with those of plain-shank nails, tested both immediately after driving and after further seasoning of the wood, can be compared if the ratios of delayed over temporary efficiencies in withdrawal resistance for grooved and plain-shank nails are examined. These efficiencies are presented in the tabulation on page 86 on a percentage basis for non-hardened and hardened, low-carbon-steel and high-carbon-steel, helically grooved *Screwtite* and annularly grooved *Stronghold* nails, as compared with the respective plain-shank nails.

The effectiveness of replacement of plain shank nails with properly grooved nails may also be proved by the fact that *Stronghold* nails, for example, improved the strength of the conventional unsheathed housing frame as much as four to six times. This may be indicative of the effects attained if advantage is taken of some of the recent developments in the fields of nails and nailing.

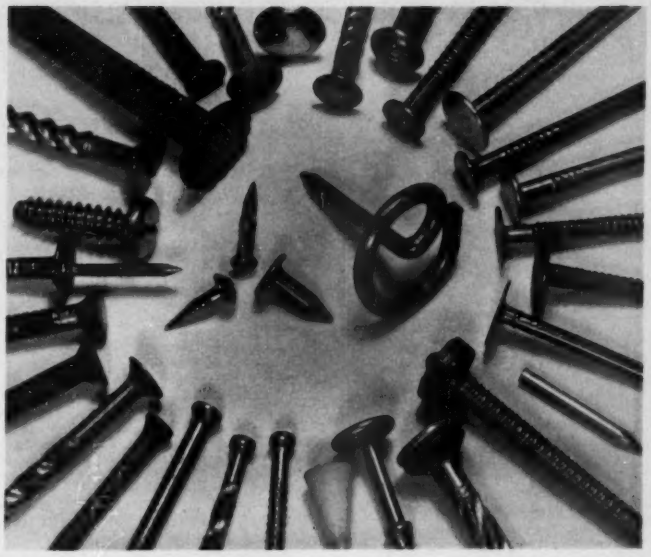


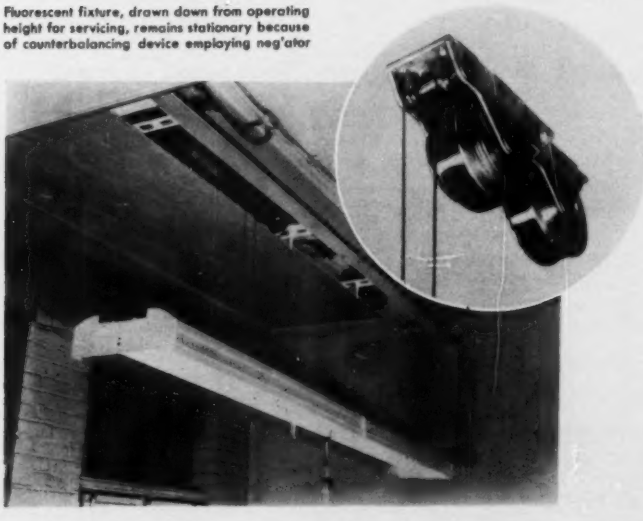
Fig. 2. View of some nail heads

The data here presented are the results of investigations in progress in the Wood Research Laboratory of the Virginia Polytechnic Institute under the sponsorship of the Independent Nail and Packing Co. of Bridgewater, Mass., the manufacturer of the grooved nails described.

Engineering News-Record, Vol. 144, No. 14, pp. 32-34, April 6, 1950.

Neg'ator-balanced Lighting Fixtures Can Be Serviced at Floor Level

Fluorescent fixture, drawn down from operating height for servicing, remains stationary because of counterbalancing device employing neg'ator



CLEANING and servicing of fluorescent lighting fixtures by regular power plant housekeeping personnel working at floor level is permitted by a simple counterbalancing device based on the neg'ator, described in September 1949 issue. Industrial and commercial lighting fixtures of all sizes may be drawn down from any operating height to remain stationary at a convenient level for replacement of tubes or starters and cleaning of reflecting surfaces. Power is automatically disconnected from each fixture as it is lowered.

Counterbalancing of a fixture's weight at all levels is provided in minimum space, without bulky deadweight mechanisms, by two neg'ator B-motors (photo insert) mounted in the fixture housing. In the B-motor, the neg'ator, a strip of flat spring material formed so that its relaxed shape is a tight coil, is wound from the storage bushing (on the right) onto the output bushing carrying the cable drum as the fixture is pulled down. The constant counterbalancing force is produced by the neg'ator trying to return to its relaxed shape on the storage bushing.

Fixture shown was developed by The Thompson Electric Co. with the participation of Curtis Lighting, Inc., and the Hunter Spring Co.

Basic Power Plant FIGURING

By WILLIAM H. ENGELMAN

Mechanical Engineer, Cleveland, Ohio

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How to Figure What an Air Compressor Is Doing — Properties of Air; Mechanical and Volumetric Efficiency; Checking the Flow Meters; Compressor Testing

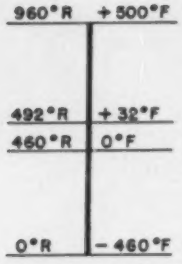


Fig. 1. Relation between Fahrenheit temperature and Rankine (absolute) temperature

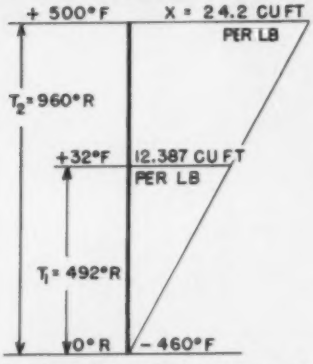


Fig. 2. How to find specific volume of air at standard atmospheric pressure for any temperature

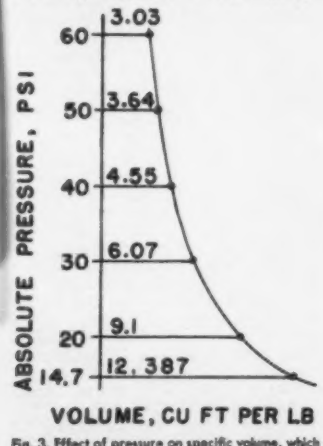


Fig. 3. Effect of pressure on specific volume, which varies inversely as the absolute pressure for a constant temperature

BEFORE you can fully understand the parts of this article concerned with testing reciprocating air compressors, you must understand a few definitions and properties of air.

First definition is that of *absolute* temperature. This is the temperature in degrees Fahrenheit plus 459.6 (usually in practice, and hereafter in this article, the figure is rounded to 460). The new figure obtained is called degrees Rankine. Thus, 60 degrees Fahrenheit (abbreviated simply F) is 60 plus 460 or 520 degrees Rankine (abbreviated simply R). Figure 1 shows this.

Second definition is that of *absolute* pressure. This is the sum of the gage pressure plus the barometric (that is, the atmospheric pressure). This cannot be shown graphically, because the barometric pressure varies with time and altitude. For clarification the following examples are given.

Example:

If the barometric pressure is 30 in. of mercury (often written 30 in. Hg), express the following as absolute pressures:

(a) the barometric pressure.
(b) a gage reading of 20 psi.
(c) a vacuum gage reading of 20 inches of mercury.

Solutions:

(a) In this case the barometric pressure is the absolute pressure. 30″ Hg = 14.73 psia = 2121.12 psfa (the a after psi and psf indicates absolute pressures. Psi is the abbreviation for pounds per square inch and psf for pounds per square foot).

(b) 30″ Hg + 20 psi = 14.73 + 20 = 34.73 psia = 5,001.12 psfa.

(c) 30″ Hg − 20″ Hg = 10″ Hg = 4.91 psia = 707.04 psfa.

Specific Volume of Air

With these two definitions in mind, we can discuss two important properties of air. First is the variation of specific volume (cubic feet per pound) of air with temperature and pressure. We must calculate the specific volume for various atmospheric conditions, by the following methods.

Specific volume of air varies directly as the absolute temperature. With this knowledge, and knowing the specific volume at any point, we can construct Fig. 2 and by proportion can find the specific volume at standard atmospheric pressure for any temperature.

Air at standard atmospheric pressure and 32 F has a volume of 12.387 cu ft per lb. By proportion, the volume at any other temperature and at standard atmospheric pressure can easily be found. Thus:

$$T_1 = 460 + 32 = 492 \text{ R}$$
$$T_2 = 460 + 500 = 960 \text{ R}$$

Thus — to find the specific volume at 500 F $T_1 : T_2 = 12.387 : x$

$$x = \frac{960 \times 12.387}{492} = 24.2 \text{ cu ft per lb}$$

Now the specific volume of air varies inversely as the absolute pressure for a constant temperature. Thus Fig. 3 can be drawn and the effect of pressure on specific volume can again be found by

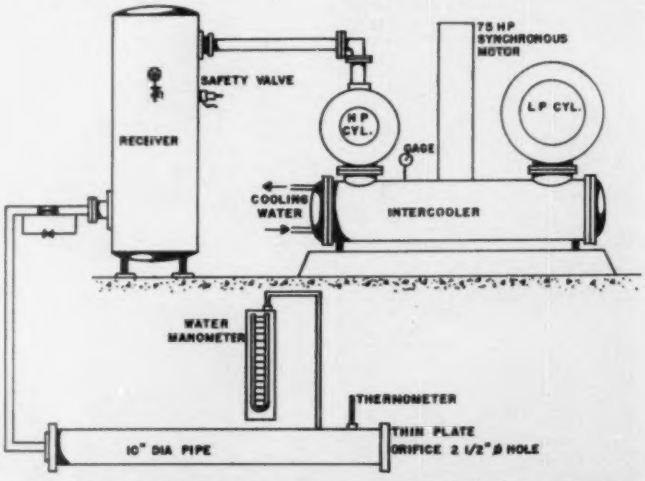


Fig. 4. Schematic diagram of an actual air compressor that was tested; figuring for test is given in text

proportion. Air at 32 F and at standard atmospheric pressure has a specific volume of 12.387 cu ft per lb. By inverse proportion, the specific volume of air at any pressure and at a temperature of 32 F can easily be found. Thus:

$P_1 = 14.696$ psia; $P_2 = 20.0$ psia;

To find specific volume at 20.0 psia, we have: $P_1:P_2 = x:12.387$

and $x = \frac{12.387 \times 14.696}{20} = 9.1$ cu ft per lb

Usually, when trying to find specific volume, the pressure will not be standard atmospheric, nor will the temperature be 32 F. In such a case, both temperature and pressure corrections must be applied.

Example: Find the specific volume of air at 14.3 psia and 60 F.

Solution: Making the pressure correction as above:

$P_1 = 14.696$ psia, and $P_2 = 14.3$ psia,

and $x = \frac{12.387 \times 14.696}{14.3} = 12.74$ cu ft per lb.

Next, using the above value as the specific volume at 32 F, make the temperature correction:

$T_1 = 32 + 460 = 492$ R;

$T_2 = 60 + 460 = 520$ R

and $x = \frac{520 \times 12.74}{492} = 13.46$ cu ft/lb.

A somewhat simpler method uses the following formula:

$$V_s = \frac{0.37 \times T_a}{p_a} = \frac{53.3 \times T_a}{P_a}$$

where V_s is the specific volume

T_a is the absolute temperature, R

p_a is the absolute pressure, psia

P_a is the absolute pressure, psfa

Example: Find the specific volume of air at 14.3 psia and 60 F.

Solution:

$T_a = 60 + 460 = 520$ R

$V_s = \frac{0.37 \times 520}{14.3} = 13.46$ cu ft/lb.

or

$V_s = \frac{53.3 \times 520}{14.3 \times 144} = 13.46$ cu ft/lb.

Thus this formula checks the method given previously.

While the above methods work well at normal pressures and temperatures, DO NOT attempt to use them at extremely low or high pressures or temperatures or both.

Temperature and Pressure Relations

It is well known that as air is compressed, its temperature rises. But it is not so well known that the work required to compress a given weight of air to a given pressure varies with the temperature of the air entering the compressor. That is, the cooler the air entering the compresor, the less is the work required to compress the air. This fact is what justifies the use of intercoolers and water-jackets, and drawing the air from outside if it is cooler there. How important this effect is, the following table shows.

Inlet temp. — F	Work relative to 60 F (Divide by this factor)
— 20	1.18
0	1.13
20	1.083
40	1.04
60	1.00
80	0.961
100	0.928
120	0.896
140	0.866
160	0.838

Thus it can be seen that approximately 1 per cent can be saved by lowering the inlet temperature 5 F.

Why and How We Test Air Compressors

Usual reasons for testing an air compressor are: (1) to see if a new installation meets its specifications and the manufacturer's guarantee; or (2) to check the performance of a machine that has been operating for some time.

We will first see how to find the mechanical efficiency of the compressor. By definition, mechanical efficiency is the ratio of the work done in compressing the air (output) to the horsepower delivered to the shaft which drives the compressor (input). That is, efficiency is output ÷ input.

In the case of a steam engine driving an air compressor, the input is found by use of indicator cards taken on the steam engine. To find the horsepower used in compressing the air, indicator cards taken on the air compressor cylinders are used.

From the above it is easy to see why it is called mechanical efficiency. The difference between the input and the output is the work lost to friction and other mechanical losses.

The other efficiency required is the volumetric efficiency. This is the ratio of the capacity to the displacement of the compressor, where the capacity is the volume of air compressed (considered at room conditions) and the displacement is the volume swept out by the low-pressure piston.

To calculate the volumetric efficiency, a method of measuring the amount of air compressed must be used. The ASME Code for testing reciprocating air compressors gives very strict rules for the use of a low pressure nozzle and the coefficients to use with these nozzles. If the test is to conform to the ASME code, then a copy of the code should be obtained and followed. For usual test procedure, a high-pressure orifice can be used with excellent results. The use of Fliegner's equation with a high-pressure orifice gives creditable results. The equation is:

$$W = 0.53\ A\ (P \div \sqrt{T})$$

Where W = weight of air in lb per sec

P = pressure in orifice chamber, psia.

T = absolute temperature in orifice chamber.

A = area of throat, sq in.

Use of the theoretical flow equation with several coefficients is given in the calculation section of the sample test below.

Air and water temperatures are of interest to engineers if a heat balance is to be calculated on the compressor. If so, the following temperatures should be read:

Water temperatures

1. Raw water supply
2. Leaving the intercooler
3. Leaving low pressure water jacket
4. Leaving the high pressure water jacket

Air temperatures

1. Air entering the compressor
2. Entering the intercooler
3. Leaving the intercooler
4. Leaving the low pressure cylinder
5. Leaving the high pressure cylinder
6. Air in the receiver

Here Is an Actual Air Compressor Test with the Figuring for Capacity and Efficiency

Compressor is an Ingersoll-Rand reciprocating, 2-stage, double-acting, 300 rpm. unit, which is driven by a 75 Hp. G. E. synchronous motor.

Compressor data: 12.5 by 10 in. low-pressure cylinder, water-jacketed
8.0 by 10 in. high-pressure cylinder, water-jacketed
1.5625-in. diameter piston rod.

Figure A is a schematic diagram of the compressor and intercooler.

Test readings were taken every 3 min. and averaged. The averaged data are:

Average room temperature, deg. F	83.0
Air temperature at orifice, deg. F	151.0
Orifice pressure, inches of water	9.5
Receiver pressure, psig	95.0
Intercooler pressure, psig	23.0
Speed, revolutions per minute	300.0
Synchronous motor power, in kw	42.3
Synchronous motor power, in hp	56.75

Calculation of Mechanical and Volumetric Efficiencies

These items are always less than unity, that is 1, or less than 100%

Mechanical efficiency is $\frac{\text{output}}{\text{input}} = \frac{42.42}{56.75} = 0.748$ or 74.8 per cent

Volumetric efficiency is $\frac{\text{capacity}}{\text{displacement}} = \frac{238}{420} = 0.566$ or 56.6 per cent

Horsepower calculations from indicator cards.

Mep—low-pressure cylinder, head end, $0.148 \times 40 = 5.92$ psi.
Mep— " " " crank end, $0.367 \times 40 = 14.68$ psi.
Mep—high-pressure cylinder, head end, $0.45 \times 100 = 45.00$ psi.
Mep— " " " crank end, $0.17 \times 100 = 17.00$ psi.

The indicated horsepower for each end = $\frac{\text{PLAN}}{33{,}000}$

Head end I-p $\frac{5.92 \times 0.833 \times 122.72 \times 300}{33{,}000} = 5.50$

Crank end I-p $\frac{14.68 \times 0.833 \times 120.8 \times 300}{33{,}000} = 13.56$

Head end H-p $\frac{45.0 \times 0.833 \times 50.27 \times 300}{33{,}000} = 17.14$

Crank end H-p $\frac{17.0 \times 0.833 \times 48.35 \times 300}{33{,}000} = 6.22$

Total indicated horsepower 42.42

All industrial plants use air for many purposes which might vary in pressure from 60 to 125 psig for the average plant. Table I shows the enormous difference between volume of free air at 60 F in cfm and volume of compressed air at 60, 80, 100, and 125 psig.

(Continued on following page)

Table I. Difference between free air volume at 60 F and volume at various gage pressures

Cubic Feet Free Air per Min. 60 F	Equivalent Cubic Feet of Compressed Air (Gage Pressure)			
	60 psig	80 psig	100 psig	125 psig
10	1.96	1.55	1.28	1.05
20	3.94	3.10	2.56	2.11
30	5.89	4.65	3.84	3.16
40	7.86	6.20	5.12	4.21
50	9.84	7.74	6.41	5.26
60	11.81	9.29	7.68	6.32
70	13.75	10.82	8.96	7.38
80	15.72	12.40	10.24	8.42
90	17.65	13.95	11.52	9.47
100	19.60	15.50	12.81	10.50
125	24.60	19.40	15.82	13.15
150	29.45	23.20	19.23	15.79
175	34.44	27.20	22.40	18.41
200	39.40	31.00	25.62	21.05
250	49.20	38.70	31.64	26.30
300	58.90	46.50	38.44	31.60
350	68.8	54.2	44.8	36.8
400	78.8	62.0	51.2	42.1
500	98.4	77.4	63.3	52.6
600	118.1	92.9	76.9	63.2
700	137.5	108.2	89.6	73.8
800	157.2	124.0	102.5	84.2
900	176.5	139.5	115.3	94.7
1000	196.0	155.0	126.6	105.1
2000	394.0	310.0	256.2	210.5

PISTON DISPLACEMENT AND SPEED

L.P. cylinder $2 \times \frac{10}{12} \times 300 \times \frac{0.852 + .839}{2}$ = 420.00 c.f.m.

H.P. cylinder $2 \times \frac{10}{12} \times 300 \times \frac{0.349 + .336}{2}$ = 171.25 c.f.m.

Average piston speed = $2 \times (10 + 12) \times 300$ = 500 ft per min.

Data on Thin-Plate Orifice

The flow equation for measuring a liquid or measuring a compressible fluid with a differential head less than 40 per cent of the upstream absolute pressure, is:

$$Q = YMCA\sqrt{2gh}$$

where:

- Q = volume rate of flow, cubic feet per second.
- Y = compressibility factor or expansion factor. This correction is applied only when using the hydraulic equation for gases and vapors.
- M = velocity of approach factor or "meter constant", see table below.
- C = coefficient of discharge; for values see discussion of each type of meter.
- A = area of minimum section of the throat, tube, or orifice, sq ft.
- g = acceleration of gravity = 32.174 ft per sec per sec.
- h = differential head in feet of the fluid flowing.

From Fig. 4	Y = 0.988
10″ = dia. pipe.	M = 1.002
2.5″ = dia. orifice.	C = 0.597
0.25 = dia. ratio.	R = 53.34, air const.
0.0625 = area ratio.	T_2 = 151 + 460
A = 4.9087 sq in.	T_1 = 83 + 460
A = 0.0341 sq ft.	h = 756.24 ft hd.

$$M = \sqrt{\frac{4^4}{4^4 - 1}} = \sqrt{1.004} = 1.002$$

Barometer 29.39 in. Hg. = 14.430 psi.
Static press. 9.5 in. H_2O = 0.343 psi.
14.773 psi.

$$O = \frac{P\,V}{R\,T_2} = \frac{(29.39 \times 0.491 + 9.5 \times 0.0361)\,144}{53.34\,(460 + 151)}$$

Table II. Properties of dry air at 14.696 psi (29.921 in. Hg)

Temp. Deg F.	Density, Lbs per Cu ft	Volume Cu ft/lb	Percent of Vol. at 70 F.	Instantaneous Spec. Heat Btu/lb/°F	Btu absorbed by 1 cu ft per deg F	Cu ft dry Air warmed 1 degree per Btu
0	0.08636	11.579	86.760	0.2411	0.0208	48.08
5	0.08542	11.707	87.719	0.2412	0.0206	48.55
10	0.08451	11.833	88.663	0.2412	0.0204	49.05
15	0.08362	11.959	89.607	0.2413	0.0202	49.56
20	0.08275	12.085	90.551	0.2413	0.0200	50.05
25	0.08189	12.212	91.503	0.2413	0.0198	50.58
30	0.08108	12.330	92.387	0.2414	0.0196	51.10
32	0.08073	12.387	92.810	0.2414	0.0195	51.30
35	0.08024	12.463	93.383	0.2414	0.0194	51.60
40	0.07944	12.582	94.275	0.2415	0.0192	52.11
45	0.07865	12.715	95.271	0.2415	0.0190	52.64
50	0.07788	12.840	96.208	0.2416	0.0188	53.17
55	0.07712	12.967	97.160	0.2416	0.0186	53.68
60	0.07638	13.094	98.111	0.2417	0.0185	54.18
65	0.07584	13.184	98.793	0.2417	0.0183	54.68
70	0.07493	13.347	100.00	0.2418	0.0181	55.19
75	0.07423	13.472	100.94	0.2418	0.0179	55.72
80	0.07354	13.598	101.89	0.2418	0.0178	56.72
85	0.07287	13.725	102.84	0.2419	0.0176	56.72
90	0.07221	13.849	103.77	0.2419	0.0175	57.25
95	0.07155	13.976	104.72	0.2420	0.0173	57.74
100	0.07091	14.102	105.66	0.2420	0.0172	58.28
105	0.07030	14.227	106.60	0.2421	0.0170	58.76
110	0.06967	14.355	107.56	0.2421	0.0169	59.28
120	0.06846	14.607	109.45	0.2422	0.0166	60.28
130	0.06730	14.859	111.34	0.2423	0.0163	61.32
140	0.06618	15.110	113.22	0.2424	0.0160	62.31
150	0.06509	15.363	115.11	0.2425	0.0158	63.37
160	0.06404	15.615	117.00	0.2426	0.0155	64.35
170	0.06302	15.868	118.89	0.2427	0.0153	65.36
180	0.06204	16.118	120.77	0.2427	0.0151	66.40
200	0.06016	16.622	124.55	0.2429	0.0146	68.41
220	0.05838	17.129	128.35	0.2431	0.0142	70.48
260	0.05514	18.136	135.89	0.2435	0.0134	74.46
300	0.05223	19.146	143.46	0.2438	0.0127	78.50
350	0.04900	20.408	152.91	0.2443	0.0120	83.55
400	0.04615	21.668	162.36	0.2447	0.0113	88.50
450	0.04361	22.930	171.80	0.2452	0.0107	93.46
500	0.04134	24.190	181.25	0.2456	0.0102	98.24
600	0.03744	26.709	200.12	0.2465	0.0092	108.35
800	0.03149	31.756	237.94	0.2483	0.0078	127.88
1000	0.02718	36.805	275.77	0.2501	0.0068	147.07
1500	0.02024	49.407	370.20	0.2560	0.0052	192.31
2000	0.01612	62.034	464.81	0.2656	0.0043	232.56

The Meter Constant $M = \sqrt{\frac{r^2}{r^2 - 1}} = \sqrt{\frac{R^2}{R^2 - 1}}$

R = diameter ratio of upstream pipe diameter to throat diameter.
r = ratio of pipe area to throat area.

VELOCITY OF APPROACH FACTOR M for orifices, nozzles, and Venturi tubes.

Dia. ratio R/r.	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55
Factor M.....	1.001	1.002	1.004	1.008	1.013	1.021	1.033	1.049

O = 0.06527 cu ft per lb, density of air.

$$h = \frac{p}{12} \times \frac{\text{Wt. of 1 cu ft water}}{\text{Wt. of 1 cu ft of air}} = \frac{62.3\,p}{12 \times \text{Wt. air}} = \frac{5.196\,p}{\text{Wt. air cu ft}}$$

$$\text{Finally } h = \frac{5.196 \times 9.5}{0.06527} = 756.24 \text{ ft head}$$

$$Q = YMCA \times 60 \times \sqrt{2gh} = 0.988 \times 1.002 \times 0.597 \times 0.0341 \times 60 \times 8.02 \times \sqrt{756.24}$$

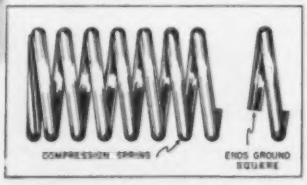
Q = 9.694 × 27.5 = 266.58 c.f.m. at ¾ load.

Wt = 266.58 × 0.06527 = 17.40 lb per min. at ¾ load.

$$Q_{std} = \frac{266.58 \times 543 \times 14.77}{611 \times 14.7} = 238.0 \text{ cu ft free air per min. at ¾ load.}$$

Checking the weight—238.0 × 0.0732 = 17.42 lb.

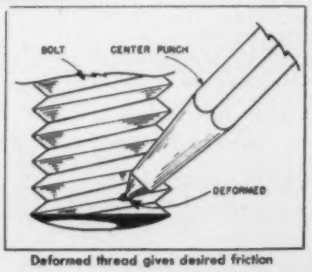
EMERGENCY LOCK WASHER



An emergency lock washer may be made by cutting one turn from a spring

TIGHTENING BOLTS

WHEN TIGHTENING bolts with a ratchet wrench in hard-to-reach places it is often difficult to ratchet the wrench, since the bolt threads do not possess sufficient friction to permit the ratchet to operate. By slightly deforming one of the threads near the point of the bolt with a center punch, sufficient friction can be obtained to overcome this difficulty.



Deformed thread gives desired friction

PRACTICAL HINTS AND KINKS

ELIMINATING WATER HAMMER IN HEATING COILS

BY CLOYD J. RAY

IN ONE OF OUR plants serious trouble was experienced in the operation of hot water generators. To explain this a short description of the equipment and setup is necessary.

There are three 46 in. by 108 in. vertical tanks equipped with copper coils of the bent-tube type. The steam supply is through thermostatic temperature regulators. The coils are drained by inverted bucket traps, one for each coil and discharge to the common return. The common return discharges into a feedwater heater located 19 ft above the coils. A back pressure of 10 psi is carried on the heater. Under this setup, water hammer raised Cain with the coils, in fact, it ruined them in a short time. Vacuum breakers were placed on the coils and this helped considerably but we still had trouble. Perhaps I should mention here that the heated water is for laundry use, which means the load fluctuated widely.

It is apparent no condensate can be drained from the coil unless there is at least 20 psig in the coil. When the demand for hot water falls off and the steam supply is throttled to a low point by the regulators the pressure in the coil, due to the steam condensing, becomes too low to move the condensate until the coil is practically full of water. What happens from there on out is easy to see (and easy to hear).

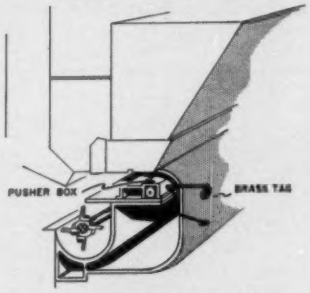
To overcome the difficulty, we installed thermal air valves between the traps and coils and led the air valve discharge to a small electrically driven condensate recovery pump as shown in the sketch.

While not a perfect setup, we have had no further trouble since installing it and the cost was slight. We also recover small flows of condensate from other sources with this outfit.

SHEAR WIRE BREAKAGE INDICATOR FOR SPREADER STOKERS

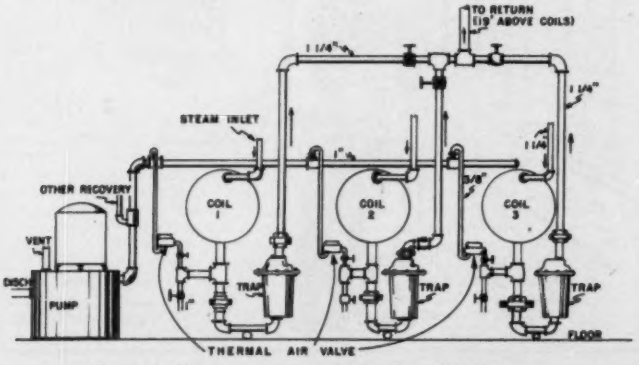
BY J. C. TORRESANO

THE SHEAR WIRES on some types of spreader stokers often break due to large lumps of coal or other materials jamming the revolving paddles. The fireman has no way of knowing a feeder has stopped until the boiler pressure has dropped and



Sketch showing installation of indicator on spreader stoker

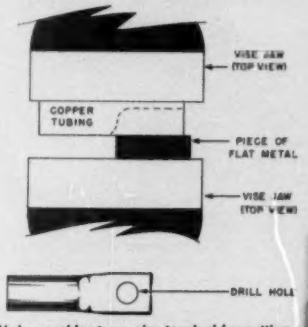
at high loads this happens very fast. So if the trouble is not caught in time the plant could lose its load. A simple indicator can be made from a length of ¼ in. rod and a brass disc. A hole is drilled through the stoker cover and the pusher box is tapped for the rod, which is allowed to stick through the cover 3 or 4 inches. The brass tag is from a loop on the end of the rod and as the pusher box moves the tag will swing freely and the fireman can tell at a glance if one of the spreaders has stopped.



Connections of hot water generators and the condensate recovery system

CAN'T FIND A WIRE TERMINAL? MAKE ONE OF TUBING

SOMETIMES you need a particular size of solder-type wire terminal, and for one reason or another you can't get it. But you can readily make a substitute by flattening a short length of suitably-sized copper tubing in a vise and drilling a hole through it, as shown in the sketch.



Make a solder type wire terminal by putting a flat metal piece against one end of a piece of copper tubing in a vise and squeezing the end with the vise. Metal piece must be a little thicker than the "squeeze," of course

PROTECT YOUR PLANT AGAINST LIGHTNING DAMAGE

YOU SHOULD NOT consider your plant secure from lightning damage if you permit susceptible equipment and structures to be without adequate lightning protective equipment. Attention to certain vulnerable portions of the plant will provide you with a greater margin of safety against a direct attack from nature's power houses.

Stacks — Be sure that all stacks, whether metal, masonry or concrete, are properly protected. Grounding of a metal stack alone should suffice; all other stacks should be equipped with an approved lightning rod installation.

Storage tanks — Outside storage tanks, especially those containing liquids that will burn, should be grounded in an approved manner; at least two connections to driven grounds are usually necessary with more needed on larger tanks.

Process equipment — Outside process equipment, such as towers, stills and conveyors should each have its own protective ground.

Transformers — Outside transformers, sub-stations and other similar installations should all be pro-

tected in accordance with the National Electrical Code.

Structures — Those structures projecting above buildings such as signs, flag poles, aerials, metal gutters and cornices should also be protected in an approved manner against lightning damage.

Proper maintenance of the foregoing protection equipment is as important as proper installation, according to the *Sentinel* of Factory Insurance Association. Visual inspection alone is not sufficient to determine the actual protective value of an installation. Instrument tests, which can be made by your public utility company, will determine the electrical efficiency of protective grounds and these tests should be made periodically.

SCREWDRIVER FOR CONFINED SPACE

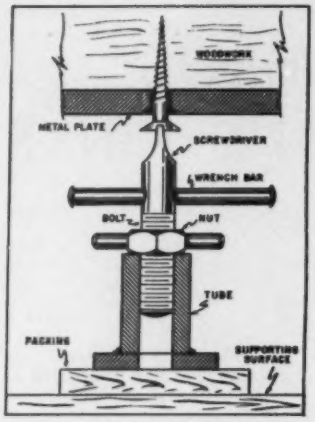
BY F. E. RILEY

AT TIMES large wood screws have to be driven into surfaces which do not permit the admission of a sufficiently powerful screwdriver. When securing metal plates to sections of overhead woodwork with wood screws, the tops of machines, cupboards, storage racks and other equipment prevent access with screwdrivers and prevent also sufficient pressure to be applied in an upward direction. The screwdriver illustrated in the sketch will overcome these difficulties.

The screwdriver blade is made from a ½ in. diameter bolt suitably shaped at its top and case hardened. The threaded portion of the bolt slides into the bore of a piece of steel tube which has a circular plate welded on to form a base. The screwdriver bolt is drilled to take a wrench handle. Below this is a standard half nut with two short handles welded on so that a spanner is not required to turn the nut.

In use, the wood screw is started into the overhead woodwork and the screwdriver blade is fitted into the screw slot. Packing may be placed under the base of the screwdriver to raise it to a convenient height and to give support from below. Holding the nut with the left hand and turning the bolt with the right hand will cause the wood screw to thread its way into the wood. If the thread pitch of the screwdriver bolt is approximately equal to that of the wood screw, the screw will be driven into the wood. If the wood screw and bolt have different thread pitches, it will be necessary to rotate the nut with the left hand so that it is in contact with the top of the tube throughout the operation and so that the screwdriver blade is pushed hard into the bottom of the slot in head of wood screw.

When the screw is driven home into the wood, the screwdriver may be removed by screwing the nut up the bolt, then the screwdriver bolt will slip down into the tube.



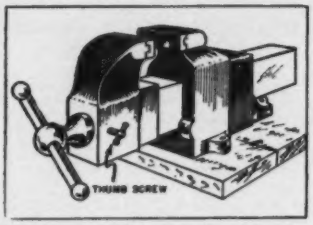
This unique screwdriver comes in handy when securing screws in confined space

SEIZING PREVENTION

TO PREVENT parts from seizing, always apply a coating of powdered or fine flake graphite and lubricating oil, mixed to consistency of thin paste, to pipe threads of unions, valve bonnets, check valve tops, valve and trap bolts, joint gaskets.

THUMB SCREW SECURES VISE JAW

AT TIMES a vise is used to hold material that cannot be compressed tightly without damage. If at such times the vise handle happens to stop in such a position that its weight causes it to rotate and open the vise jaws, the material will be released.



Thumb screw inserted to clamp vise spindle collar will bind it from rotating

To overcome this difficulty, a hole may be drilled and tapped in the side of the movable jaw, and a thumb screw inserted to clamp the vise spindle collar and thus bind it against rotating. Be sure to locate the tapped hole in such a position as to prevent the end of the thumb screw from striking any set screws in the vise spindle collar.

"That's 'stand-by' equipment in case we have a breakdown"

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—

HERE'S HOW IT WORKS

YOUR QUESTION about some problem in operation, maintenance or design will be published, signed only with your initials.

Answers to your questions from other readers will be sent you as soon as received, then published as space permits, so that all may have the information.

You, too, answer questions from other engineers in the same way. You get paid well for published answers and also get the credit for knowing them.

If other engineers help you solve your problem, you express your thanks, via the Q & A editor.

Simple, isn't it? And effective! Just ask engineers who have tried it!

Answer No. 482

CAN WE USE OILY EXHAUST STEAM FOR OVERFIRE AIR JETS?

Yes, It Should Work, says Fitzpatrick

PROPOSED use of steam-air jets which are also known as air-aspirating steam jets, is not unorthodox with exhaust steam at 10 psi, for these steam air-jets are simple in operation and can provide extremely close regulation of steam and air-flow. Steam jets have lower initial investment costs than air-jet systems and can be constructed of common 125-lb pipe-fittings and standard weight pipe.

As far as oil content is concerned in this exhaust steam, any possible oil mixture is inconsequential and due to the action of the jet would be dispersed and actually consumed in the combustion process. If necessary for peace of mind, a simple oil separator could be used to remove the majority of the oil.

R. E. A. does not give any dimensions of his boiler installation and he should consider the following alternatives, which could also be used instead of the steam-jets. One is the use of a steam-turbine blower. This can use the exhaust steam satisfactorily although it is much more expensive than the first system.

Another possibility is air from the forced-draft system. This is simply installed at a lower cost than steam-jets for applications where high turbulence is not required and furnace area is comparatively small.

To use the 10-psi exhaust steam pressure, one must consider that the minimum effective steam pressure that can be used depends on furnace design and operation as well as general jet design. Some steam jet installations will operate satisfactorily on pressures as low as 5 psi. However, fuel bed penetration and turbulence drop with decrease in steam pressure necessitate more jets for coverage at this low pressure. Usually 25 psi is the lowest pressure now being used on new installations to eliminate the requirement for extensive jet coverage of the furnace.

General practice is to employ about 10 per cent of the air theoretically required as overfire air for fuel combustion. Where load variations occur or where quantity of volative is released suddenly, quantities as high as 25 per cent may be required. If excess air in the furnace is difficult to control and only turbulence is the main requirement, quantities as low as 3 per cent at relatively low velocities at pressures around 5 to 10 psi may be used.

Many newer installations of jets arrange the steam nozzles on a header that can be removed for servicing while the boiler is in operation.

In every case, jet assemblies should be so valved that the steam can be reduced on low load. Photoelectric control is generally used to indicate need of overfire jet air. This control is usually programed to open an electric solenoid steam valve permitting steam to enter the jet piping system. As soon as the smoke condition clears, the valve closes. This system is simple, fully automatic, and conserves steam where not required in the furnace.

Overfire jets, in addition to preventing smoke and fly ash emission, will also reduce slag and soot formation on boiler tubes. The final boiler temperatures will also be reduced and the flame shortened. The smoking limit of the furnace will also be increased together with boiler and furnace efficiency. A substantial reduction of carbon content of the cinder carryover will also result.

If these steam jets are used intermittently, steam condensation should be removed through a steam trap for better efficiency. Incidentally, this 10,000 lb of steam at 10 psi, for which R. E. A. is trying to find a use through these jets, is a very valuable commodity, and if he does not want to reclaim the surplus from the proposed jet system, he should use a heat exchanger to recover some of this valuable waste heat. When you analyze this 10,000 lbs each day, this is about 250,000 lb of steam in a work-day month, which is now going to waste.

L. W. FITZPATRICK
Jefferson City, Mo.

Answer No. 483

WHAT'S THE BEST WAY TO DETERMINE AMOUNT OF BOILER BLOWDOWN?

Fitzpatrick Compares the Various Tests

THREE TYPES of test procedure that S. E. R. has listed for boiler blowdown control have certain limitations. Each has its own particular advantages and two of the methods can be used in conjunction with each other.

In his plant operation it would be to his advantage to start a daily tabulated analysis of his "return" water from his plant system. By comparing his lowest solids content of this return water against his boiler water concentrations for that particular day, he will find the happy medium as to the highest concentrations his boiler will carry with negligible carryover.

Usually the maximum boiler water concentrations stipulated by the American Boiler Manufacturer's Association in standard guarantees of steam purity will give a representative figure as to boiler-water concentration factor. These are as follows:

Pressure	Maximum Concentrations
Psi	Ppm
0–300	3,500
301–450	3,000
451–600	2,500
601–750	2,000
751–900	1,500
901–1000	1,250
1001–1500	1,000

However, general plant operation will always enter into a satisfactory boiler-water solids determination, which should be checked to get the lowest solids in a condensate return. This calculation should also hold during the winter and fall heating months, when steam output is much greater.

In the first method of testing (hydrometer) an ordinary hydrometer, which measures specific gravity in the same manner as employed in checking regular storage batteries, is not satisfactory because of the temperature errors introduced, which nullify the actual solids calculated content of a water.

Water-treatment companies offer calibrated water hydrometers wherein the actual temperature of the water sample is adjusted and these give a good approximate reading. Usually three readings are taken, with temperature variations of 5 deg, and then averaged. The hydrometer method is satisfactory when there are high concentrations.

The conductance method is an electrical resistance measurement and is recommended when the chlorides in feedwater are low or subject to wide and sudden fluctuation. The

greater the amount of dissolved solids in water, the higher the electrical conductivity. This is always a direct measure of solids content because dissolved salts break up and ionize in water permitting passage of electric current through the solution. Thus, when many ions are present the water resistance is always reduced.

The conductance test is more accurate than chemical tests for chlorides or sulfates because ions of all kinds respond, not just those of the two substances mentioned. Materials including insoluble sludge and ordinary organic matter, which does not ionize, are not measured in the water by the conductivity method.

The conductivity method offers speed and reasonable accuracy by all plant personnel. Commercial instruments cost from $90 upwards and give a range of 300 to 6,000 ppm of dissolved solids. Supplementary models also give a smaller range of 0 to 40 ppm for measurement of steam condensate.

However, the conductance method is usually taken for a "control" reference point, because it cannot make any particular designation as to the ppm of salts. There is no exact relationship between the meter readings as this is dependent on individual water analysis originally.

The method of evaporation and actual weighing of the solids is not generally used in the United States although it is often used with superprecision equipment in Europe. The average power plant cannot afford such equipment, when you consider the ratios of solids to water being determined, namely, 2,500 to 3,000 ppm for boiler water up to 300 lbs psig.

For speed in control testing in the power plant, it is only necessary to add phenolphthalein indicator and sufficient sulfuric acid to neutralize the sample to the colorless side of phenolphthalein indication. Then the chloride test can be run. It is not necessary to neutralize the boiler-water test sample to methyl orange when making a routine chloride control test, if the total ppm alkalinity is not desired at the time.

Basically, S. E. R. will find the following factors all interwoven in plant operation, which will limit the amount of boiler-water concentration. They can all be used as indicators of the allowable boiler-water concentration for his particular plant operation:

1. Suspended Solids: — This may prove to be the main factor because these solids may promote carryover or develop boiler scale. These solids can only be determined by a hydrometer on an unfiltered boiler water sample.

2. Alkalinity: — High alkalinity will cause foaming. The alkalinity control test should always be used in conjunction with other blowdown factors, since alkalinity can be varied up or down by the internal boiler-water treatment compounds used for water stabilization. It is necessary to have a definite upper alkalinity limit beyond which blowdown should be made regardless of any other factor.

This is stated in the formula 2 × (P Alkalinity) − (M Alkalinity) should always equal 171 to 427 ppm (or 10 to 25 grains per gal) for small boilers up to 300 psig. Total alkalinity should not exceed 20 per cent of the total boiler-water concentrations when solids are close to upper limits as listed for A.B.M.A. standards.

3. Silica: — May be the limiting factor and in cases the blowdown control factor would be the maximum allowable silica content of the water. On the basis of silica, it is also possible to calculate concentrations of other substances in the water when the silica is in maximum range. This can be definitely established through experimentation to arrive at a definite factor relationship of all substances when the silica is at a certain ppm range.

Using alkalinity measurement as a basis for the control of silica, however, is not always satisfactory, for alkalinity will not necessarily vary with water concentrations due to the addition of internal boiler-water treating compounds.

S. E. R. will find, if he establishes a control point based on his maximum allowable operating concentration of his boiler water, taking the foregoing factors into consideration, that he can arrive at a very satisfactory water conditioning program with guaranteed results and operation economy in blowdown.

L. W. FITZPATRICK

Jefferson City, Mo.

Answer No. 485

CAN VERTICAL STEAM ENGINE RUN WITHOUT CYLINDER LUBRICATION?

THIS QUESTION on a very old problem was raised by Ambitious Al, who felt that, if it can be done, it would permit very effective use of engines in many cases where their exhaust steam could be used provided it was free of oil.

In June, July and August issues, several readers assured Al that it has been done frequently, but only when the throttle steam is saturated or has very low superheat. It is not so good on modern engines using high temperature steam, principally because the temperature may be high enough to affect the oil, also because metal expansion problems are different at the higher temperatures. Water lubrication, as the method is called when oil is not used, has been quite common in marine practice.

It's Often Done on Marine Engines, says Giles

YOU CAN see water lubrication of reciprocating steam engines in any steam-engine-driven ship on a saturated steam condensing cycle.

Even as recently as the last war, both the Navy and the Maritime Commission were building ships using water-lubricated steam engines. This is done to avoid the condenser fouling and the feed water de-oiling problems. When this type of ship arrives in port, the cylinder heads must be removed and the inside of the cylinder oiled to prevent rusting during the shut-down period.

An industrial plant shuts down every day and would have a difficult problem to provide this protection. The labor required to hand oil the cylinder walls once a day and wipe them dry before starting the next day would be excessive. If the engine had a very short shut-down time period, this would probably not be necessary except on week ends.

As you live in Chicago, I think you can find very good examples of water-lubricated engines in some of the ships that tie up at your port. Of course the trend in marine engineering is toward turbine or Diesel drive but there are still many older vessels using vertical steam engines. Talking to the operating engineers should give you a complete picture of the problem.

Los Angeles, Calif. STUART GILES

Answer No. 486

WHAT'S RIGHT ANSWER TO PIPE CONDENSATION PROBLEM

HERE'S an answer to V.L.G's. question some time ago asking for the rate of condensation per square foot of 1 in. pipe coil carrying 135 psig steam and submerged in 60 F water. Several widely differing answers were given to this question and J.C.P. in the June issue pointed out that V.L.G. must now be even more confused than before. Perhaps this answer will help dispel some of the confusion.

Hetzel Says 103.6 or 120.9 lb per hr per sq ft

FOLLOWING is my solution to this question:

U = 300 Btu per sq ft per deg F per hr
or
U = 350 Btu per sq ft per deg F per hr
(from Engineering Handbook)

W = weight of condensate, lb

h = heat of vaporization of 135 psig steam, Btu per lb = 863.87

t = temperature of 135 psig steam = 358.43

t_t = temperature difference between H_2O and steam = 358.43 − 60 = 298.43

$$W = \frac{U \times t_t}{h}$$

$$\therefore W = \frac{300 \times 298.43}{863.87} = 103.6 \text{ lb per hr per sq ft}$$

$$\text{or } W = \frac{350 \times 298.43}{863.87} = 120.9 \text{ lb per hr per sq ft}$$

Dayton, Ohio H. W. HETZEL
Manager
Frank M. Tait Station

B-F Gas to Fuel 60,000 kw at New Fairless Steel Works

Fig. 1.—Power plant boiler room structural steel goes up for new 60,000-kw electric generating and turbo-blower plant to serve new Fairless Works of U. S. Steel Corp., now under construction at Morrisville, Pa.

At new Fairless Works of U. S. Steel Corp., Morrisville, Pa., three 300,000-lb-per-hr boilers will supply steam for two 30,000-kw condensing turbine generators and three 110,000-cfm turbo-blowers. . . . Condenser discharge recirculated to plant service. . . . Stage heaters omitted for simplicity. . . . Blast furnace gas the primary fuel for economy, with other gases and oil supplementary. . . . Extensive water treatment. . . . Windowless building

Fig. 2.—(Right.) Circulating water tunnels, under construction at new Fairless Works Power Plant, will conduct water for two 30,000-kw turbine-generator condensers and three 110,000-cfm turbo-blower condensers

THE NEW POWER PLANT at U. S. Steel's Fairless Works, Morrisville, Penna., will use blast furnace gas, a by-product of pig iron manufacture, as a primary fuel to effect maximum economies in operation and to conserve other natural fuels in producing electric power. Excavations for the initial power installations were begun on May 1.

Major installations will include two turbine generators for 60-cycle current, three turbo-blowers, three boilers, and a building to house the equipment. Auxiliary equipment will include the necessary pumps, compressors, condensers, fans, deaerators, water-treatment plant, controls and instrumentation, and electric substations. Gibbs & Hill, Inc. are the consulting engineers.

The turbine generators, operating at 3,600 rpm at 850 psi, 900 F, will each generate 30,000 kw at 13,800 v. They will be equipped with two 25,000-sq-ft condensers, each of which will be provided with one motor-driven and one turbine-driven condensate pump. The pumps will be 2-stage, center-suction types.

Cooling water for each condenser will be provided by two horizontal, single-stage, double-suction volute centrifugal motor-driven pumps with 24-in. suction and 24-in. discharge openings. Each pump will have a rated capacity of 13,000 gpm.

There will be five 69,000-v electric substations: a main substation in the sheet and tin mill area, and one each at Biles Island, the hot strip mill, the power house, and the pump house. Each will be equipped with power transformers, switchgear, supervisory control and telemetering equipment. The substations will have power transformers as follows: Biles Island — two 50,000 kva; main — two 33,000 kva; hot strip — two 33,000 kva; pump house — two 4,687 kva; and power house — two 33,000 kva.

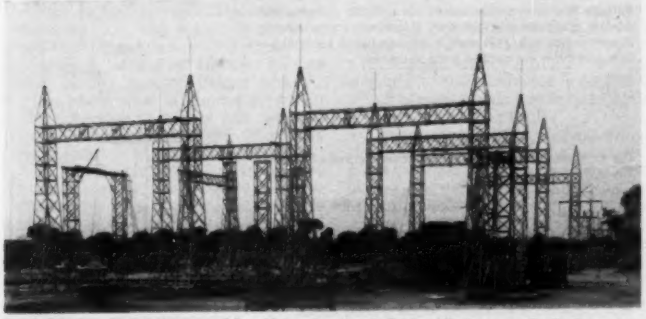


Fig. 3. Biles Island substation, one of five 69-kv substations in Fairless Works power distribution system

(*Continued on page 113*)

(*Continued from page 73*)

fects of terminating radio transmission lines in impedances which do not match those of the electrical line itself are strictly analogous to a mechanical system formed by a cable span and its support clamps, insulators and towers. Radio transmission over cables is extremely faulty if not impossible when the termination is not matched for electrical impedance. When there is not proper termination the electrical waves are reflected, and standing waves result with only a small energy input. The standing waves of aeolian mechanical vibrations on a cable span are analogous. Hence, the techniques of radio transmission are very helpful in furthering the study of aeolian vibrations.

By using the electrical analog, it is verified that Stockbridge dampers and Armor rods are not true dampers at all. There is very little energy dissipated in these devices.

What They Really Are

The Stockbridge damper is analogous to tuned impedance matching devices. The damper introduces a reflected wave into the system at a point one-quarter wave length from troublesome reflection points so that the introduced wave is 180 degrees out of phase with the unwanted reflection, and it has the proper amplitude to exactly cancel the unwanted wave. Hence, for most effectiveness, multiple dampers (2, 4, 6 or 8 in number) are mounted near each suspension support to cancel the first harmonic and several higher harmonics of vibration.

Armor rods are like untuned matching devices as tapered horns of a microwave guide. They introduce reflections all along the length of the taper. Hence, armor rods were found to be much more effective when they, too, are tapered. A somewhat similar effect is obtained by using very long tapered support clamps.

During the last nine years the Bonneville Power Administration has accumulated valuable field experience, and has made many conductor vibration studies on their 33 transmission lines, in the Pacific Northwest. Most of these lines are 230-kv steel-tower designs. The Aluminum Company of America and the American Steel and Wire Co. have been most cooperative and helpful in supporting the research program.

The Bonneville Power Administration has extensive plans for continuing their studies. In addition, they have given Washington State College a considerable grant of test equipment for conductor vibration study, as well as an initial two-year contract to insure a research program.

Thirty thousand vibration dampers have been installed or are planned on 4567 conductor spans and 216 overhead ground wire spans. All of these dampers will have been mounted with the aid of a simple hot-line tool on the energized 230 kv lines. This prevents outages, and is also more economical in promoting safety than with de-energized lines whereon it is necessary to install temporary grounds on either side of the section being worked.

Data are given which again show that two or three Stockbridge dampers on each side of the support clamp are most desirable to eliminate the harmful vibrations. The actual number of dampers used depends upon the span length. For example, one damper is used on each end of spans up to 1200 ft; two dampers on each end of spans 1200 ft, to 2200 ft; three dampers on each end of spans 2200 ft to 3200 ft, etc., on 500 MCM expanded copper conductors as well as on 795 MCM ASCR conductors. In order to obtain the greatest effectiveness over a wide band of frequencies, the spacing of the dampers at one end of the span are "staggered" with respect to those at other end by using, for example, 4 ft and 3½ ft spacing at the respective span ends.

All of the ACSR conductors on the BPA Lines were originally installed with tapered armor rods. No signs of fatigue failures have been found on the ten-year-old line. However, numerous breakages of 1 to 8 of the outer copper strands have been discovered on a 500 MCM expanded high-strength copper conductor at 23½ per cent of the towers in a 100-mile section of a 230 kv line which did not have armor rod or dampers. Special low-magnetic preformed armor rods are now being applied to repair the 500 MCM copper cable to its original strength, and also to combat further aeolian vibration.

The investigators confirm that it is highly desirable or necessary to encourage the present trend towards improvement of the design of suspension clamps, armor rods and other conductor hardware and accessories, particularly in the transmission of power at the higher voltages of 230 kv and above.

The Department of Water and Power, City of Los Angeles, has had 15 years of experience operating circuits of the 287.5 kv Hoover Transmission Lines. Initially dampers, of torsional design, were applied in locations which were regarded as particu-

Tabulation Showing Correspondence Between Electrical and Mechanical Systems

Electrical Term			Mechanical Term	
voltage or emf		E(t)	F(t)	force
inductance		L	M	mass
charge		Q	x	distance
current		$I = \frac{dQ}{dt}$	$v = \frac{dx}{dt}$	velocity
resistance		R	c	damping
reciprocal of capacitance (elastance)		$\frac{1}{C}$	k	spring constant (elastance)
magnetic energy	M.E. $= \frac{1}{2}LI^2$		K.E. $= \frac{1}{2}Mv^2$	kinetic energy
potential energy	P.E. $= \frac{1}{2}\frac{Q^2}{C}$		P.E. $= \frac{1}{2}kX^2$	potential energy
power loss		$I^2 R$	$c\,v^2$	power loss

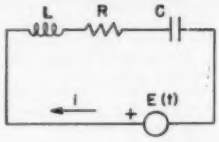


Fig. 2. LRC electrical system of one degree of freedom. The differential equation is $\frac{Ld^2Q}{dt^2} + \frac{RdQ}{dt} + \frac{Q}{C} = E(t)$, where $\frac{dQ}{dt} = I$ is the current in amperes or time rate of change of charge, Q is charge in coulombs, R is resistance in ohms, C is capacitance in farads, L is inductance in henrys, and E(t) is the applied voltage in volts.

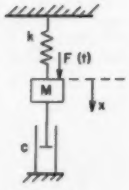


Fig. 3. Mechanical spring system of one degree of freedom. The differential equation is $\frac{Md^2x}{dt^2} + \frac{cdx}{dt} + kx = F(t)$, where $\frac{dx}{dt} = v$ is the velocity in inches per second or time rate of change of distance, x is distance (displacement) in inches, c is dynamic damping constant in pound-seconds per inch, k is linear spring constant in pounds per inch, M is mass in pound-seconds squared per inch, and F(t) is the applied force in pounds.

Fig. 4. Mechanical torsional system of one degree of freedom. The differential equation is $\frac{Jd^2\Theta}{dt^2} + R\frac{d\Theta}{dt} + K\Theta = T(t)$, where $\frac{d\Theta}{dt} = w$ is the angular velocity in radians per second of time rate of change of angular displacement, Θ is angular displacement in radians, R is dynamic damping constant in pound-inch-seconds per radian, K is torsional spring constant in pound-inches per radian, J is mass moment of inertia in pound-inch-seconds squared per radian, and T(t) is the applied torque in pound-inches.

Fig. 5. Electrical system of two degrees of freedom. The two differential equations which describe the activity are:

$$L_1 \frac{d^2Q_1}{dt^2} + R_1 \frac{dQ_1}{dt} + \frac{C_1 C_{12}}{C_1 + C_{12}} Q_1 - \frac{1}{C_{12}} Q_2 = E_1(t)$$

$$L_2 \frac{d^2Q_2}{dt^2} + R_2 \frac{dQ_2}{dt} + \frac{C_{12} C_2}{C_2 + C_{12}} Q_2 - \frac{1}{C_{12}} Q_1 = E_2(t)$$

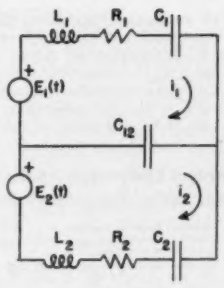
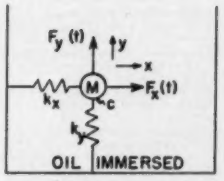


Fig. 6. Mechanical system of two degrees of freedom. The two differential equations which describe the activity are:

$$M \frac{d^2x}{dt^2} + c_x \frac{dx}{dt} + k_x x + k_y f(x) = F_x(t)$$

$$M \frac{d^2y}{dt^2} + c_y \frac{dy}{dt} + k_y y + k_x f(y) = F_y(t)$$



larly bad from a vibration standpoint. About 10 per cent of the line was equipped with these dampers. Not until late 1949 was any trouble experienced due to vibration. Soon several other breaks were located. Then a complete line inspection was made, tower by tower. A total of 9 segment cracks were found. The startling discovery was that vibration was being experienced far in excess of any ever measured in the first two years of service. A 180-ft length of the Type HH conductor was cut from the line at one of the vibrating points.

Oiling Cable

It was found that much less energy was required to vibrate the cable after its 15 years in service than when it was new. Also, it was disclosed that the torsional dampers were far less effective than when the cable was new. By oiling the cable so that oil lubricated the dovetail joints of the Type HH conductor, a condition was produced wherein the required energy to produce vibrations was greater than that required when new. Also, it was found that the torsional dampers were as effective with the oiled conductor as with the new. Hence, it was deduced that the increased friction between the sections of the conductor became so large after 15 years service that sliding was no longer present. Thus, absorption of the energy which produces the vibration was reduced to a value where severe vibrations developed.

It has been found that either the Stockbridge or the Swedish damper are highly effective in reducing the vibrations in the 287.5 kv line to a safe level. It is anticipated that total application of dampers of one of these types will be necessary to insure the desired 50-year life with a margin of safety.

The ground wires of the Boulder Transmission Lines are of ⅛ inch Extra High Strength galvanized strand having a breaking strength of 18,000 lb. A normal tension of 1800 lb at 60 F is used — i.e., 10 per cent of ultimate. Although special suspension clamps of the trunnion type are used, no vibration dampers have ever been used on the overhead ground wires. At this time there has been no reason to consider their use.

It is realized that this lower tension permits greater sag which must be compensated by higher supports at the towers. However, this design is economically desirable.

The Department of Water and Power has also designed a 258-mile 230 kv single-circuit steel-tower line which is now under construction. It is being shielded with the same ½ in. Extra High Strength wire. A normal tension of 2100 lb at 60 F is being used — i.e., 12 per cent of ultimate. No dampers are considered.

It was found that it is economical as well as practical to utilize fairly low tensions in both the conductors and the ground wires. The new line is being constructed with 954,000 cm ACSR conductors in 1100-ft spans at a normal tension of 4600 lb at 60 F and a maximum tension of 10,000 lb with ice and wind loading. The rated strength of the conductor is 34,200 lb which gives a tension of only 13.5 per cent of ultimate at 60 F.

Control of possible aeolian vibrations is considered of sufficient importance that armor rods and Stockbridge dampers are being installed at all supports on the new 230 kv line.

The Hydro-Electric Power Commission of Ontario, Canada, has a Type HH copper-conductor 220 kv line similar to the 287.5 kv Boulder Transmission Line. This line is 42 miles in length, has a double circuit, and is rated 220 kv. The conductor is of the 500,000 cm Type HH construction. The spans are 880 ft, and the conductors are sagged for 20 per cent tension at 60 F. The line has been in service for nine years, and the spans are undamped. Complete inspections have indicated no vibration difficulties whatsoever.

Since 1940 the Commission has adopted the practice of omitting armor rods completely and using dampers exclusively to prevent damage by aeolian vibration on all high voltage circuits. One damper is installed on each side of each suspension support. The mounting distance is six feet from the support for 795,000 cm ACSR conductor, and is less for smaller conductors. More than two dampers are arbitrarily used at each support for spans over 1200 ft. Line tensions of 15 to 19 per cent at 60 F are used.

The following two lines were built in 1940: (1) a 110-kv line, 477,000 cm ACSR, average span 1000 ft, 60 F tension 15.5 per cent, and 103 miles long; and (2) a 220-kv line, 795,000 cm ACSR, average span 1150 ft, 60 F tension 19 per cent, and 271 miles in length. Both were equipped with only dampers, one third of them are of the T and B torsional type and the other two thirds are of the Stockbridge type. The ten-year inspection showed no wear or breakage due to aeolian vibration.

A trial attempt was made to control galloping conductors in a high voltage 2200-ft river span, which had given trouble on three occasions. Torsional dampers were installed, 8 per span per conductor. No claims were made for this as a cure for galloping. However, it is noteworthy that the span has been free of galloping for approximately four years.

Improvements Possible

The Stockbridge damper, Armor rods and several other dampers are means of mechanical impedance matching. By proper design and installation these dampers (impedance matching devices) can be made much more effective.

The limitations for stressing overhead high-strength shield or grounding cable should be lowered to 15 per cent of ultimate at 60 F as compared with the present code of 25 per cent at 60 F. Flexible suspension clamps should be used.

The conductors of high voltage transmission lines should be sagged to carry a tension not to exceed 20 per cent of ultimate strength of 60 F. Stockbridge or similar dampers should best be installed at all supports.

It has been found desirable in many cases to also install armor rods at each flexible suspension support and dead end. It is known that armor rods effectively suppress vibration and give added protection. However, the collected data indicate that properly installed dampers of the Stockbridge type, and others, should sufficiently reduce aeolian vibrations.

BOKARO

(*Continued from page 67*)

forced draft fan located on the fan floor 70 ft above the operating floor takes suction from the room, forces the air through a regenerative type air preheater, and then through the duct work to the wind-box and burners. Tempering air ducts with automatically controlled dampers are provided between the windbox and each of the pulverizers to insure the proper temperature in the mills.

Each induced draft fan, driven by a constant speed motor, draws the gas for the steam generator, through the air preheater, mechanical dust collector and duct work to the fan, and discharges the gas through the up-

(*Continued on page 116*)

Principal Mechanical Equipment—Bokaro Steam Power Station, Bokaro, India, Damodar Valley Corporation

FUEL EQUIPMENT

Drag Scraper System—Beaumont Birch Co. 250 tons per hr, average haul 300 ft, cable speed 470 ft per min, scraper capacity 12,400 lb.

Coal Handling System—Link Belt Co. Dual system, 250 tons per hr each, from track and reclaiming hoppers to bunkers.

Motor Drives for Above Systems—General Electric Co. All motors totally enclosed.

Steel Coal Bunker Hoppers, 12—Bethlehem Steel Export Corp.

Coal Hopper Arch Breakers and Chutes—Connery Construction Co.

Coal Scales, 12—Richardson Scale Co. Capacity 15 tons per hr, charge 200 lb.

Coal Scale Drives, 12—General Electric Co. ½ hp, 1500 rpm, 3 phase, 50 cycles, 380 v totally enclosed induction motors.

Coal Feeders, 12—Combustion Engineering-Superheater, Inc. Integral with pulverizers.

Coal Feeder Drives, 12—General Electric Co. 1 hp, 1500 rpm, 3 phase, 50 cycles, 380 v drip proof induction motors.

Coal Pulverizers, 12—Combustion Engineering-Superheater, Inc. Capacity 12 tons per hr.

Coal Pulverizer drives, 12—General Electric Co. 250 hp, 1000 rpm, 3 phase, 50 cycles, 3000 v drip proof induction motors.

Lighting Equipment and Burners—Combustion Engineering-Superheater, Inc. 24 burners and lighting guns, 2 lighting oil pumps 10 gpm and 350 psig.

Ash Handling System, 3—Allen-Sherman-Hoff Co. Hydraulic system, capacity for three units 180 tons per hr bottom ash and 45 tons per hr fly ash.

Fly Ash Collectors—Western Precipitation Corp. Multiclone type, collecting hoppers sized for 8 hr storage.

Ash Water Pumps, 3—Worthington Pump & Machinery Corp. 1800 gpm, 346 ft discharge head, 7 stage, vertical turbine.

Ash Water Pump Drives, 3—General Electric Co. 200 hp, 1500 rpm, 3 phase, 50 cycle, 3000 v drip proof induction motors.

Ash Pumps, 2—Allen-Sherman-Hoff Co. 4000 gpm, 45 psig, horizontal.

Ash Pump Drives, 2—General Electric Co. 150 hp, 750 rpm, 3 phase, 50 cycles, 380 v drip proof induction motors.

Bilge pumps, 2—Allen-Sherman-Hoff Co. 900 gpm, 60 ft discharge head, vertical.

Bilge Pump Drives, 2—General Electric Co. 30 hp, 1500 rpm, 3 phase, 50 cycles. 380 v drip proof induction motors.

Lighting Oil Transfer Pumps, 2—Sier-Bath Gear & Pump Co., Inc. 150 gpm, 25 psig, positive displacement.

Lighting Oil Pump Drives, 2—General Electric Co. 7½ hp, 1000 rpm, 3 phase, 50 cycles, 380 v, totally enclosed induction motors.

PIPING

Piping Fabricator—Blaw-Knox Construction Co.

Piping Erectors—The Kuljian Corp.

Cast Iron Piping—United States Pipe & Foundry Co.

Ashcelite Piping—Allen-Sherman-Hoff Co.

Turbine Extraction Valves—Atwood & Morrill Co.

Motor Operated Valves—Edward Valve Co., Chapman Valve Manufacturing Co.

Standard Valves—Chapman Valve Manufacturing Co., Crane Co.

Small Valves—Hancock Valve Co.

Boiler Feedwater Recirculating and Hand By-Pass Valves—Republic Flow Meter Co.

Butterfly Valves—R-S Products Corp.

Control Valves—Fisher Governor Co.

MISCELLANEOUS EQUIPMENT

Air Compressors, 2 (Station)—Ingersoll-Rand Co. Single stage, double acting horizontal, 222 cfm, 100 psig.

Air Compressor Drives, 2—General Electric Co. 50 hp, 1000 rpm, 3 phase, 50 cycles, 380 v, drip proof induction motors.

Air Compressors, 3 (Control)—Worthington Pump & Machinery Corp. Single stage, double acting horizontal, 96.3 cfm, 80 psig.

Air Compressor Drives, 3—General Electric Co. 20 hp, 1000 rpm, 3 phase, 50 cycles, 380 v, drip proof induction motors.

Station Service Pumps, 3—Warner Vaughan Co. (Peerless Pump) 3500 gpm, 165 ft discharge head, 3 stage, vertical turbine.

Station Service Pump Drives, 3—General Electric Co. 200 hp, 1500 rpm, 3 phase, 50 cycles, 380 v, totally enclosed induction motors.

Condensate Transfer Pumps, 6—Warner Vaughan Co. (Peerless Pump) 100 gpm, 239 ft discharge head, 2 stage, horizontal centrifugal.

Condensate Storage Pump, 1—Warner Vaughan Co. (Peerless Pump) 200 gpm, 75 ft discharge head, double suction, horizontal centrifugal.

Chlorinated Water Pumps, 3—Warner Vaughan Co. (Peerless Pump) 50 gpm, 162 ft discharge head, 4 stage, vertical turbine.

Sump Pumps, 6—Warner Vaughan Co. (Peerless Pump). 200 gpm, 40 ft discharge head, single stage, non-clog.

Fire Pump, 1—Warner Vaughan Co. (Peerless Pump). 1000 gpm, 150 psig, 7 stage, vertical turbine, dual drive gasoline engine and electric motor.

Lubricating Oil Transfer Pumps, 4—DeLaval Steam Turbine Co. 67 gpm, 50 psig, positive displacement, horizontal.

Chemical Feed Pumps, 9—Proportionsers, Inc. Simplex horizontal reciprocating, 2.3 to 22.8 gph, adjustable pressure to 1950 psig max, 3–100 gal chem tanks.

Miscellaneous Tanks—Kumardhubi Engineering Works, Ltd., India Buffalo Tank Co.

Power House Crane, 1—Manning, Maxwell & Moore, Inc. Main hoist—125 tons, auxiliary hoist—20 tons, 44 ft span, 60 ft lift.

Station Auxiliary Crane, 1—Manning, Maxwell & Moore, Inc. Main hoist—25 tons, auxiliary hoist—5 tons, 25 ft span, 60 ft lift.

Gantry Crane, 1—W. H. Broady & Co., Ltd., India. Hoist—15 ton, 40 ft span, 55 ft lift.

Insulation—Elwat Magnesia Manufacturing Co. Pipe covering and block insulation.

Passenger and Freight Elevator—Otis Elevator Co.

Motor Drives not Listed—General Electric Co.

Temperature Recorders—Brown Instrument Co.

Indicating Thermometers—Moeller Instrument Co.

Pressure Gages—Energy Control Co.

Machine Shop Equipment—Fitzpatrick & Walsh Equipment.

Prime Contractors (Equipment and Engineering)—International General Electric Co.

Prime Contractors (Construction, Initial Operation and Consulting Engineers)—The Kuljian Corp.

STEAM GENERATING EQUIPMENT

Boilers, 6—Combustion Engineering-Superheater, Inc. 300,000 lb per hr cont., superheater outlet 895 psig, 910 F, radiant heat furnace, two drum 17,167 sq ft heating surface, 21,625 cu ft furnace, heat release 17,000 btu per cu ft, 14,484 sq ft waterwall surface, pulverized coal fired.

Superheaters, 6—Combustion Engineering-Superheater, Inc. Continuous-tube pendent type, two stage, center gas by-pass control, 9534 sq ft heating surface.

Soot blowers—Vulcan Soot Blower Corp. Automatic, electric, steam.

Forced Draft Fans, 6—Buffalo Forge Co. 89,000 cfm, 10.2 in. water, 100 F, vane control, outlet damper.

Forced Draft Fan Drives, 6—General Electric Co. 200 hp, 1000 rpm, 3 phase, 50 cycles, 3000 v direct connected drip proof induction motors.

Induced Draft Fans, 6—Buffalo Forge Co. 164,000 cfm, 12.5 in. water, 300 F, inlet damper control, outlet damper.

Induced Draft Fan Drives, 6—General Electric Co. 500 hp, 750 rpm, 3 phase, 50 cycles, 3000 v, direct connected drip proof induction motors.

Steel Stacks, 3—Connery Construction Co. Self-supporting, 85 ft high, 14-ft dia.

Ducts and Breechings—Connery Construction Co.

Combustion Control and Instruments—Baily Meter Co.

Air Heaters, 6—The Air Preheater Corp. Ljungstrom regenerative type, 74,800 sq ft heating surface.

POWER GENERATING EQUIPMENT

Turbine Generators, 3—General Electric Co. 50,000 kw standard, tandem compound, double flow, 850 psig, 900 F, 1.7 in. Hg abs., 58,800 kva, 3 phase, 50 cycles, 13.8 kv, 3000 rpm, hydrogen-cooled generator.

Condensers, 3—Foster Wheeler Corp. Surface type 50,000 sq ft, single pass, divided waterboxes, rubber expansion joints, twin-element 2-stage air ejector, inter-and-after condenser, one priming air ejector.

Circulating-Water Pumps, 6—Foster Wheeler Corp. Single stage, mixed flow, vertical, 25,000 gpm, 30 ft head.

Circulating-Water Pump Drives, 6—General Electric Co. 250 hp, 500 rpm, 3 phase, 50 cycles, 3000 v, totally enclosed induction motors.

Traveling Water Screens, 6—Link Belt Co. 30,000 gpm, 10 ft trays, ⅜ in. mesh copper cloth.

Traveling Water Screen Drives, 6—General Electric Co. 1½ hp, 1800 rpm, 3 phase, 50 cycles, 380 v totally enclosed induction motors with fluid drive.

Turbine Oil Purification System—DeLaval Separator Co. Centrifuge separator, steam coil settling tanks and Bowser polishing filters.

FEEDWATER EQUIPMENT

Condensate Pumps, 6—Foster Wheeler Corp. 1,000 gpm, 325 ft discharge head, five stage, vertical.

Condensate Pump Drives, 6—General Electric Co. 125 hp, 1000 rpm, 3 phase, 50 cycles, 380 v drip proof induction motors.

Boiler Feed Pumps, 9—Ingersoll Rand Co. 700 gpm, 1150 psig, 8 stage, semi-barrel.

Boiler Feed Pump Drives, 9—General Electric Co. 700 hp, 3000 rpm, 3 phase, 50 cycles, 3000 v totally enclosed water cooled induction motors.

Fourth-Stage Feedwater Heaters, 3—Lummus Co. Integral de-superheating and subcooling zones, closed type, vertical, U-tube, 3740 sq ft effective heating surface, raises 546,590 lb per hr water from 348.0 to 412.6 F, 295 psig, shell pressure, 1130 psig tube pressure.

Eighth-Stage Feedwater Heaters, 3—Lummus Co. Integral de-superheating and subcooling zones, closed type, vertical, U-tube, 3756 sq ft effective heating surface, raises 546,590 lb per hr water from 290.3 to 348.0 F, 131 psig, shell pressure, 1130 psig tube pressure.

Sixteenth-Stage Feedwater Heaters, 3—Lummus Co. Vertical, closed type, subcooling zone, U-tube, 1820 sq ft effective surface, raises 434,040 lb per hr water from 150.5 to 228.9 F, 37 psig shell pressure, 83 psig tube pressure.

Nineteenth-Stage Feedwater Heaters, 3—Lummus Co. Horizontal, closed type, subcooling zone, U-tube, 2250 sq ft effective surface, raises 434,040 lb per hr water from 98.2 to 150.5 F, 19 psig shell pressure, 93 psig tube pressure.

Deaerating Heaters, 3—Worthington Pump & Machinery Corp. Horizontal tray type, 588,100 lb per hr water flow, 10 min. storage capacity, 50 psig shell pressure, U-tube vent condenser.

Evaporator Deaerators, 3—Worthington Pump & Machinery Corp. Spray type, 20,000 lb per hr water flow, 2 min. storage capacity, 40 psig shell pressure, U-tube vent condenser.

Evaporators, 3—Lummus Co. Horizontal, U-tube, 20,290 lb per hr vapor at 50 psig when supplied with 19,350 lb per hr steam at 131 psig.

Feedwater Regulators, 6—Bailey Meter Co. Three element.

Feedwater Softeners, 3—Cochrane Corp. Carbonaceous zeolite, 70 gpm each.

Feedwater Filters, 3—Cochrane Corp. 70 gpm each.

Water Treatment Plant—Permutit Co. Coagulation and precipitation with alum and lime, 300 gpm, rectangular basin.

Raw Water Pumps, 2—Worthington Pump & Machinery Corp. 300 gpm, 100 ft discharge head, 3 stage, vertical turbine.

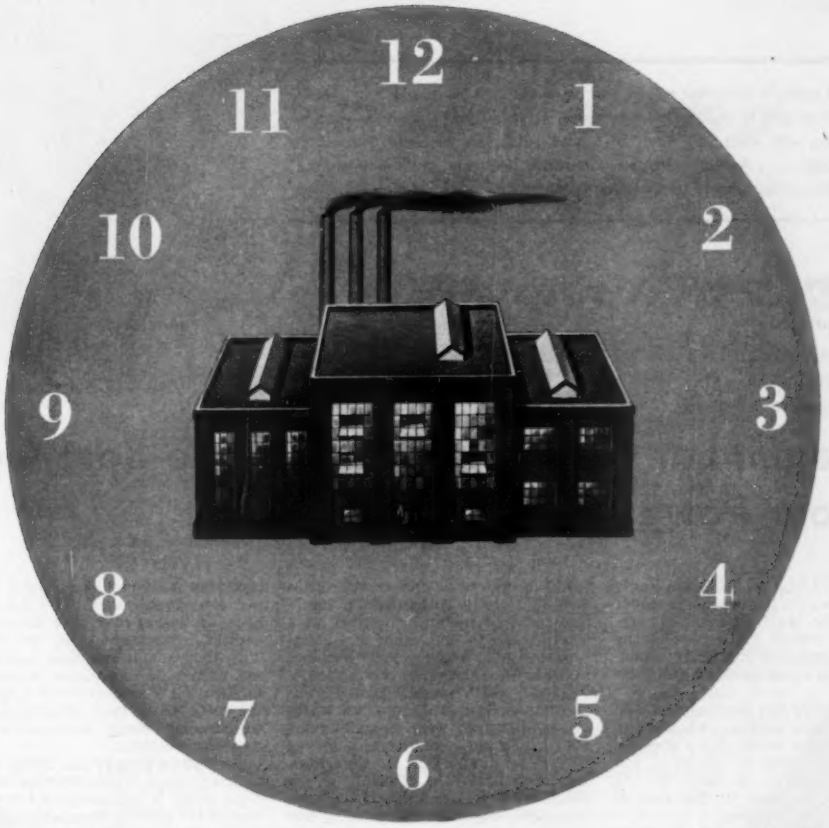
Raw Water Pump Drives, 2—General Electric Co. 15 hp, 1500 rpm, 3 phase, 50 cycles, 380 v totally enclosed induction motors.

Coagulated Water Pumps, 3—Worthington Pump & Machinery Corp. 300 gpm, 100 ft discharge head, 3 stage, vertical turbine.

Coagulated Water Pump Drives, 3—General Electric Co. 15 hp, 1500 rpm, 3 phase, 50 cycles, 380 v drip proof induction motors.

Treated Water Pumps, 2—Warner Vaughan Co. (Peerless Pumps) 180 gpm, 300 ft discharge head, 16 stage, vertical turbine.

Treated Water Pump Drives, 2—General Electric Co. 20 hp, 1600 rpm, 3 phase, 50 cycles, 380 v drip proof induction motors.



How to be sure of 'round-the-clock' production

This is The BETZ INDICATOR, a monthly publication devoted to general discussion of all water problems. It's free. Write.

Any way you look at it, improper water conditioning resulting in scale, foaming, corrosion, algae, embrittlement or a host of other "traditional bugaboos", is one sure way to stymie efficient plant operation . . . and pile up costs! That's why alert management recognizes that a direct route to uninterrupted production is through the use of an adequate and well-balanced program of water conditioning.

If *you* are result-conscious, then BETZ can be of assistance to you. Here in one organization you will find the facilities and services necessary for the efficient solution of all water problems. May we have a BETZ engineer call? He'll show you how you can get 'round-the-clock' results in your plant . . . quickly . . . economically. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal, 1.

BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

Over half of today's industrial boilers are more than 20 years old. . . . Many industrial power plants need modernization or replacement, but you may have to keep going with what you have. . . . Old equipment losses 3 times those 25 years ago. . . . Answer:—Modern operating methods and maintenance. . . . Here's how management can help you use them until modernization is possible

DAVID MOFFAT MYERS

Myers & Addington

Consulting Engineers

Shows How

Management Can Help You Get the Best Out of Your Power Plant

PRACTICALLY all industrial plants require steam for heating or processing or for both purposes. Therefore steam boilers are a part of the typical manufacturing plant where the power is either generated or purchased.

Plant owners can learn a great deal from the public utilities, whose rates for power have come down steadily through the years by virtue of improved efficiency, in spite of the tremendous increase in the cost of fuel, labor and supplies.

But the industrial cost of steam and power has gone steadily up and up through these same years, due to these same cost rises. These have not (in the usual case) been mitigated by increased efficiencies as adopted by the utilities.

Universally, plant management is concerned about the high and still-rising costs of fuel and labor; and labor in the ultimate analysis is, of course, the governing factor in the cost of fuel and steam and everything else.

Many Industrial Boilers Are Old

But management, with some exceptions, has not followed the policy of the utilities of constantly modernizing their methods and quipment to reduce the cost of steam to a minimum. A sample survey has indicated that over half of industrial boilers are 20 years old or older and a third are 30 to over 40 years of age.

All plant owners are faced with the problem of most efficient use of capital. Commonly, new funds applied to improvements in the production departments bring a quicker return than when they are spent for modernization of steam and power facilities. This explains why so many old and wasteful steam plants are found in otherwise efficient establishments. The old equipment is therefore patched up and operated at a heavy waste in fuel, labor and maintenance until replacement becomes necessary to continued production.

These same annual wastes measured in dollars are now about three times what they were 25 to 30 years ago. Under such conditions a survey should be made, first, to determine how to improve the efficiency of the old plant, and, secondly, to work out a properly engineered program of economical and modern replacement.

The first step involves little or no capital expenditure and helps to build up a savings account for later application to the final program.

What Modern Methods Can Do

The improvement in boiler units has been so great during the last quarter century that when replacements are indicated, there now exists an attractive opportunity to reduce the cost of steam for process and heating, regardless of whether the power supply is purchased or generated. A self-liquidating investment is thus insured.

Since an inefficient boiler plant may annually consume up to twice its cost in fuel alone, it should be clear that such plants should be scrapped and replaced with a modern and properly engineered installation as soon as possible. Any plant 20 years old should most certainly be expertly surveyed to determine the right plan of modernization, together with estimates of costs and savings.

Operating methods and equipment — these two factors determine efficiency. If a boiler plant is old and out of date, the use of modern operating methods will make it give all the efficiency of which it is capable. In some cases, as much as 25 per cent to 50 per cent more steam for the same consumption of fuel, with little or no capital investment, can be made. This may sound startling, but there are numerous old plants where the application of strictly modern operating methods to both generation and utilization of steam would show very handsome returns.

As I have already indicated, management must decide whether for the time being it will adopt all possible means for getting the maximum efficiency from the old plant. Or, on the other hand, shall it truly and thoroughly adopt a modernization program and scrap the old money-eaters? In some cases, the old plant is in such bad repair that replacement is the only economical procedure.

First Step—Survey Losses

Assuming, however, it is resolved for the time being to tune up the old boiler plant to do its best, don't fail to make another resolution. Find out where the steam is going and stop wasting it. Handling these two jobs right is just like mending a hole in the money bag.

A second future article will deal with the problem of stopping steam waste with your existing plant, both in connection with its generation and with its distribution and use in the factory. In that article, the author will take a walk with you through your power plant. We shall be asking leading questions as we look around, and as key information is received, certain thoughts regarding possible economies will automatically pass through our minds. These ideas can then be explained to management, which will gladly help carry them out on seeing how much they can do with little or no capital investment.

Here's why your plant needs a GAI-TRONICS Power Plant Communication System

...custom-built by Power Plant Design-Engineers!

EFFICIENCY! *Everyday-operations* run *smoother* because a modern GAI-TRONICS System is *fast* and *sure*. Critical manpower is used most effectively. Executives, operators, departments, and maintenance men are called by *name* instead of by slow, confusing code calls. Two-way or group conversations take place over special telephone handsets. These are designed for noise-free operation in *extremely high noise* areas even without acoustic booths! GAI-TRONICS has proved itself in the plants of many electric utilities throughout the United States and abroad.

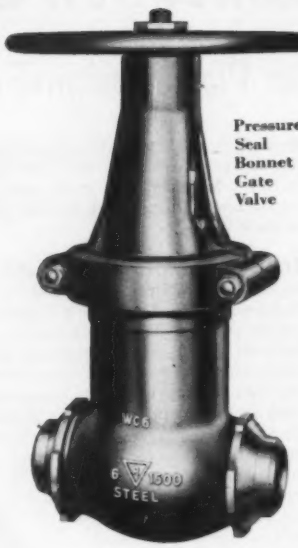
EMERGENCY! *When trouble occurs*, a GAI-TRONICS System alerts and coordinates all affected areas *by voice* at once—even though the system is otherwise in operation. All areas can hear all sides of emergency instructions, if necessary, or telephone-type privacy may be had at the flick of a switch! Maintenance men can be located and dispatched to the job without delay.

ECONOMY! *A* GAI-TRONICS *System* is surprisingly low-priced because it is designed, by men thoroughly acquainted with power plant requirements, to provide *all* internal communication facilities in *one* system! By preventing damage to costly plant equipment and keeping your plant "on-the-line" during an emergency, a GAI-TRONICS System may pay for itself in minutes! *Fast* and *sure* GAI-TRONICS communication minimizes accidents, misunderstood orders, improves labor relations, and lowers production costs.

FREE . . . a booklet or a demonstration! POWER PLANT COMMUNICATION SYSTEMS is an informative booklet showing GAI-TRONICS at work under the most difficult sound conditions. Read it before deciding on communications for your plant. It will save you money! If you should like a demonstration . . . we will bring a portable GAI-TRONICS unit to your plant and prove its worth under any noise conditions! Write today!

GAI

R·P&C
VALVES



Pressure Seal Bonnet Gate Valve

for High Pressure, High Temperature Service

● R-P&C pressure seal bonnet joint is tight under varying service conditions—is easy to disassemble for inspection—reduces weight.

R-P&C compensating wedge will not stick—opens and closes easier than solid wedge—assures tightness under minor line strains.

Ask your R-P&C representative to explain the details of these valves

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

"Intentionally Better"
READING-PRATT & CADY VALVES

New ENGINEERING BOOKS

Architectural Graphic Standards, by C. G. Ramsey and H. R. Sleeper. 4th Edition. Size 9 by 11½ in.: 614 pp including index; cloth bound; published by John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y.; price $10.00.

Almost double the size of the previous edition, this fourth edition presents up-to-date information on all aspects of building. As in earlier editions, the information is presented by means of illustrations giving comprehensive details of the processes and materials required in architectural and allied fields.

Proper dimensions, recommended usage and procedures, equipment, furnishings, fittings and appliances are covered.

Among the new subjects included in the fourth edition are special fireplaces, precast concrete joists, modern wall types, corrugated wire glass roofing and siding, steel stairs, modular casement windows, eaves and watertables for flat roofs, fiber board and wall board for interiors, acoustical data and materials, electric stairways, and many others.

Engineering Formulas and Tables. Size 5 by 7¼ in.; 176 pp; loose leaf binding; published by Lefax, Sheridan Building, Philadelphia 7, Pa.; price $1.50.

Here is a revised loose-leaf data book containing mathematical tables and formulae to help you solve problems in arithmetic, geometry, algebra, trigonometry, analytical geometry and calculus.

The material is arranged in thumb-indexed sections for ready reference. The sections cover: mathematics; measures; materials; gages, screws, etc.; mechanics; electric, magnetic and fundamental units; hydraulics; structural data; reinforced concrete; pipe and fittings; steam tables; and mathematical tables.

Dimensional Analysis and Theory of Models, by Henry L. Langhaar. Size 6 by 9 in.; 162 pp; cloth bound; published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.; price $4.00.

This book explains the application of dimensional analysis to any particular phenomenon and what variables should be included in the equation.

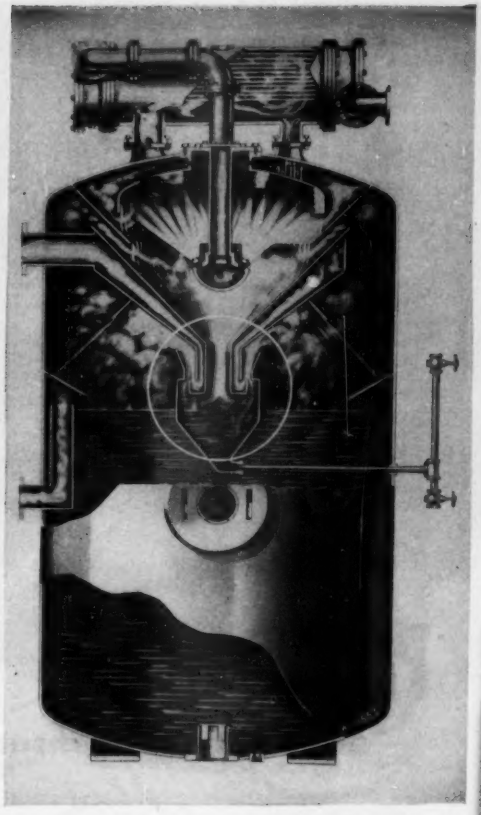
Some of the items covered in the ten chapters will give some idea of the many phases in which dimensional analysis plays a part: use of models; model ship propellers; wind loads on large windows; bending of ductile beams; stresses in an arched dam; run-off from a watershed; condensation in a vertical pipe; and many others.

Several features of the book include: an algebraic development of the theory of dimensional analysis that reduces the theory to a branch of algebra and connects it closely with the theory of linear algebraic equations; separate chapters devoted respectively to applications of dimensional analysis in stress analysis, fluid mechanics, thermal problems, and electrical problems.

Industrial Relations Handbook. Edited by John C. Aspley and Eugene Whitmore. Third Edition; Size 5 by 7¾ in.; 1244 pp, including bibliography and index; flexible leatherette binding; published by The Dartnell Corp., 4660 Ravenswood Ave. Chicago 40, Ill.; price $10.00.

In this handbook are a thousand-and-one answers to your employee relations

(Continued on page 107)



Hard scale, formed on the trays of deaerating evaporator preheaters, is no longer the big problem it used to be.

In a large central station (name on request), the preheaters had to be cleaned every three weeks, and the units were completely shut down at that time from eight to ten hours.

Then Worthington steam-jet deaerators were installed—with a "blowdown" head designed by Worthington engineers. This special head allows the operator to remove harmful deposits at regular intervals *while the unit continues in service.* It also provides for simple and speedy acid cleaning of critical parts, when necessary, without even opening an access door or removing any parts from the unit.

Compare The "Time-Outs"

The Worthington unit, given a short blowdown once each shift, stays in continuous operation with maximum deaeration for periods of at least 8 months. When the acid treatment is given at the end of that period, the job is finished in under three hours.

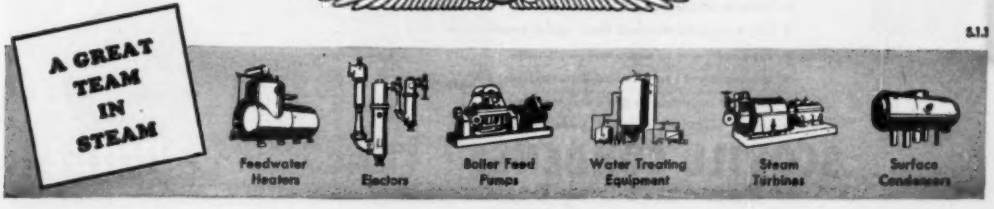
Compare this with the former record. *Then*—8 to 10 hours outage every three weeks and labor by a *crew* of men. Now—with Worthington's blowdown head—operation uninterrupted during regular short blowdown, with a shutdown for acid cleaning only once in almost a year, requiring only one man and three hours!

Worthington Makes Deaerating Equipment News

Developments like this, applicable to any deaerators operating under conditions of scaling, are typical of Worthington's engineering firsts in water treating and deaerating equipment.

Worthington manufactures all of the equipment needed in a complete water treating installation. For further information on why *there's more worth in Worthington*, address Worthington Pump and Machinery Corporation, Steam Power Div., Harrison, N. J.

WORTHINGTON



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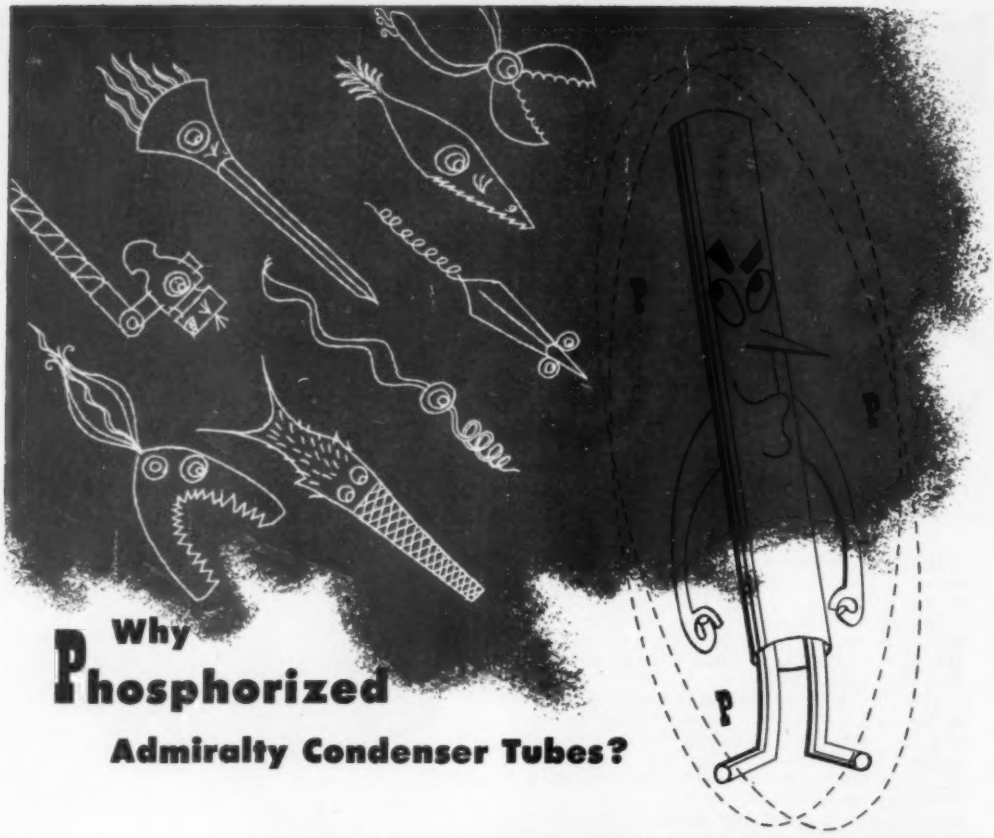

Why Phosphorized Admiralty Condenser Tubes?

...OUTSTANDING RESISTANCE TO DEZINCIFICATION

Adding as little as 0.02% phosphorus to Admiralty greatly increases its resistance to dezincification, without impairing its excellent chemical and physical properties.

In power plant service, Scovill Phosphorized Admiralty Tubes have given very satisfactory trouble-free life, proving relatively immune to dezincification and highly resistant to attack by steam and condensate and to general corrosion in fresh, salt or brackish circulating waters.

In order to assure *uniform* chemical composition and *soundness*, Scovill produces its Phosphorized Admiralty tubes by the *continuous* billet-casting process which continuously maintains the optimum amount of phosphorus. The tubes are hot-extruded from the continuous-cast billets, then are cold-drawn, annealed, cleaned and finished to produce tubes of uniform temper, gauge, straightness, roundness, diameters, length and freedom from burrs.

A Condenser Tube Booklet is available to qualified users who request it on their business letterhead. Scovill Manufacturing Co., 15 Mill St., Waterbury 20, Conn.

Only Scovill Phosphorized Admiralty Has All These Advantages...

- Uniformity and soundness resulting from Scovill continuous-casting techniques
- Relative immunity to dezincification
- Excellent performance in fresh, salt or brackish waters
- High resistance to steam and condensate
- Unquestioned heat transfer characteristics
- Superior resistance to general corrosion
- Good resistance to velocities under 7 fps.

SCOVILL CONDENSER TUBES
"You can't buy better brass"

SCOVILL
A PRODUCT OF SCOVILL

Not an instrument you buy... but a service we supply

Now *within seconds* you can get an accurate and complete picture of combustion conditions in your furnaces. A Cities Service Combustion Engineer, by applying his *exclusive* Heat Prover, will quickly secure continuous, accurate readings that reveal any oxygen excess or waste combustibles present.

Operators throughout the country, by using these instant readings as their guide, have been improving furnace output and product quality, while saving fuel.

Similar results are possible at your plant. Start the ball rolling today for a FREE Heat Prover test of your furnaces. Simply call or write your local Cities Service office . . . or else return the coupon below.

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From Western Precipitation—the organization that pioneered the commercial application of Cottrell Precipitation...

IF YOU ARE ENGAGED in any phase of industry where the recovery of dusts, fumes, fly ash, mists, fogs or other suspensions from gases is a problem, you will find this booklet on the COTTRELL Electrical Precipitator helpful and informative.

Western Precipitation pioneered and installed the first commercial application of the well-known COTTRELL Electric Precipitator—Dr. Cottrell, the inventor, being a member of the company. And for more than 42 years Western Precipitation has consistently led in developing new COTTRELL advancements and techniques for recovering suspensions from gases, both wet and dry.

This 28 page booklet summarizes many of the basic facts you should know about modern COTTRELL Precipitators—the various types available, how they operate, principal types of electrode systems and rectifiers, shell constructions, etc. As long as the supply lasts, a free copy will be sent you on request to our nearest office. Ask for Bulletin No. C 103.

28 PAGES
of helpful facts to know about
COTTRELL ELECTRICAL PRECIPITATORS

Packed with helpful COTTRELL Information!

This Western Precipitation Cottrell booklet is designed to answer questions of design engineers, plant engineers and others interested in applying Precipitators to the recovery of industrial dusts and mists. It discusses such subjects as . . .

- **Basic types of Cottrell Electric Precipitators.**
- **Principal parts of a Cottrell Precipitator.**
- **Mechanical and Electronic Rectifiers.**
- **Various types of Collecting Electrodes (rod curtains, corrugated plates, dual plates, pocket electrodes, etc.).**
- **Removal of Collected Material.**
- **Factors in Shell Construction (steel, concrete, brick, etc.).**
- **Operating Efficiencies and the Effect of Various Factors on Performance.**

. . . and many other basic Cottrell facts. Write for your free copy of Bulletin C103 today while supplies are adequate!

Western Precipitation is not affiliated with any other company in the field of electrical precipitation except its wholly owned subsidiaries, International Precipitation Corporation and the Precipitation Company of Canada, Ltd. Whether you are now contemplating the installation of a Cottrell Electrical Precipitator, or may be interested in such an installation at a future date, we can and will serve you in any part of the United States or other countries.

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...in all parts of the U.S.A. and foreign countries.

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NEW ENGINEERING BOOKS

(*Continued from page 102*)

problems. Beginning with the first chapter about Industrial Relations Today and going through the fifty-sixth chapter on Relations with Government, many of the questions you may have regarding industrial relations are explained.

Some of the chapter headings are listed to give some idea of the material covered: negotiating a labor contract; seniority problems; grievance procedures; job classification; job analysis and evaluation; production incentive plans; suggestion systems; plant communication system; and accident and fire prevention.

Steel Butt-Welding Fittings, ASA B16.9–1951; 16 pages; size 8½ by 11 in.; illustrated; published by the American Society of Mechanical Engineers, 29 W. 39th Street, New York 18, N. Y.; price 75 cents.

This standard was approved on April 17, 1951. It is sponsored by the Heating, Piping and Air Conditioning Contractors National Association, the Manufacturers Standardization Society of the Valve and Fittings Industry, and the American Society of Mechanical Engineers.

It provides overall dimensions, tolerances and markings for wrought and cast carbon and alloy steel, welding fittings, in sizes 1 to 24 in. Dimensions presented in seven tables are for long radius elbows, 180 deg returns, straight tees, reducing outlet tees, lap joint stub ends, caps and reducers. Supplementary tables contain dimensions of welded and seamless steel pipe listed by schedule numbers and by strong wall, extra strong wall and double extra strong wall.

Drill Drivers, ASA B5.27–1951; 8 pages; size 8½ by 11 in.; illustrated; published by the American Society of Mechanical Engineers, 29 W. 39th Street, New York 18, N. Y.; price 45 cents.

This American Standard on drill drivers of the split-sleeve, collet-type is sponsored by Metal Cutting Tool Institute, Society of Automotive Engineers, National Machine Tool Builder's Association and the American Society of Mechanical Engineers.

The Standard was developed to insure close tolerances in assembly of drill to driver. It gives taper dimensions, general specifications and dimensions for 135 sizes of drill drivers along with the standard and optional taper number for each size.

Boiler Water Treatment Manual for Federal Plant Operators, Handbook 5, by Louis Goldman; 94 pages; illustrated; size 6 by 9 in.; flexible fabricoid binding; published by the Bureau of Mines, U. S. Department of the Interior; obtainable from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.; price 30 cents.

This Manual was written primarily for operators or engineers of U. S. Government boiler plants. It covers internal boiler water treatment only, the basic information needed in feeding chemicals and controlling and adjusting such treatment. These methods are being used successfully in hundreds of government-operated plants.

Boilers of these plants usually operate at pressures not higher than about 300 psi and at ratings up to about 200 per cent. The methods given, therefore, are appropriate for such conditions and would not necessarily apply for higher conditions.

The Manual was prepared as a compan-

Corruflex

PACKLESS expansion joints

No packing...no lubrication...no adjustment in service...no upkeep costs. You eliminate maintenance when you install *Corruflex* joints in your pipe lines. And, they're on the job all the time...absorbing expansion and contraction...protecting lines and equipment from strain. Full-time service without servicing!

Corruflex joints are more dependable, more efficient, longer lasting because they are made by the pioneers of the expansion joint industry. They are available in sizes from 3" to 24", single or double units, single or multiple corrugations, with or without self-equalizing rings, and with flanged or welding ends. Supplied in copper, stainless steel or other alloys and with internal sleeves if required.

Corruflex joints have traverses ranging from fractions of an inch to 15" and operate under pressures from vacuum to 300 psi and temperatures from sub-zero to 1600 F.

Send for 16-page Bulletin. Complete data on all *Corruflex* joints...simplified selection charts...summary of installation practice...*Bulletin No. Y-35-51.*

AMERICAN DISTRICT STEAM COMPANY, INC. ★ North Tonawanda, N. Y.

These EVERLASTING advantages give better service from

Fig. 4001/6561. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Angle Blowing Valve.

BOILER BLOW-OFF VALVES

When you install an EVERLASTING Duplex Blow-Off Unit, you'll find that its many superiorities speak for themselves.

The sealing valve at the left is the EVERLASTING design that has been famous for more than 40 years . . . the valve with the drop-tight seal that actually improves with use because of its self-lapping action each time the valve is opened or closed . . . the valve that can't stick or jam because of its non-wedge design . . . the valve that opens in less than a quarter turn to provide unimpeded straight-through blow.

The blowing valve at the right is the equally famous EVERLASTING Angle or "Y" Valve, specially designed and equipped to withstand repeated blow-off shocks, erosion and corrosion, and without pockets that might trap and hold solids.

Each of these valves . . . and all the other EVERLASTING Boiler Blow-Off Valve types, fully meet ASME code requirements . . . assurance that they are properly designed and amply strong for the service.

Write for descriptive bulletin

EVERLASTING VALVE CO.
49 Fisk Street, Jersey City 5, N. J.

Fig. 4001/6571. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Y Blowing Valve.

Fig. 6571/6561. Duplex unit consisting of Y Sealing Valve and Angle Blowing Valve.

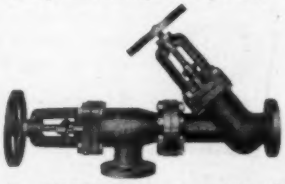

Fig. 6561/6571. Duplex unit consisting of Angle Sealing Valve and Y Blowing Valve.

Everlasting Valves

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ion booklet to Bureau of Mines **Handbook 3, Questions and Answers on Boiler Feedwater Conditioning** (obtainable from Superintendent of Documents, price 25 cents) and it is recommended that the two be studied together.

The present Manual takes up first boiler water causticity, then describes methods for feeding caustic soda or soda ash and adjusting dosage, control of scale formation, use of quebracho tannin in boiler water treatment, control of boiler and return line corrosion, boiler blowdown and boiler water carry-over, and boiler water analysis reports.

Gas Turbines, by Harry A. Sorensen; 460 pages; illustrated; size 6 by 9 in.; cloth binding; published by The Ronald Press Co., 15 E. 26th St., New York 10, N. Y.; price $6.50.

In this book, the author's objective was to present a thorough and fundamental treatment of the thermodynamic principles, elements of design, and general construction features of the gas turbine. The book treats the gas turbine as a power plant type, which can be applied to various classes of service. It strikes a level somewhere between the extremes of the highly theoretical treatise and the descriptive work. Enough of the theory of design is included to cover the general principles but there is a great deal of practical information, and specific numerical calculations are given all the way through. Operating data are included to indicate current performance and examples are extensively used to illustrate all significant calculations.

References to the recent literature of engineering societies and technical magazines covering the gas turbine are included at the end of each chapter. The subject is covered in the following general chapter divisions: After historical and descriptive introduction, the book takes up principles of thermodynamics necessary for understanding the various cycles and the operation of the gas turbine. Next come chapters on the simple open-cycle gas turbine, variations of the basic cycle, the closed-cycle gas turbine plant. Following this are chapters on the axial-flow compressor, the centrifugal and positive displacement compressor, the axial-flow turbine, combustion systems, structural design, plant performance and miscellaneous plants. An appendix gives data on properties of air and combustion gases. At the end are 12 pages of problems keyed to the corresponding chapters.

As a general textbook for the graduate student in engineering, also for the practicing engineer, this book seems to fulfill its purpose extremely well. It is up to date, as indicated by inclusion of the latest data on the exhaust-heated gas turbine, ram jet, after-burning and water injection. The many numerical calculations bring the physical quantities into the engineer's understanding from the stratosphere of thermodynamics. Latest types of equipment are shown and although the material is not quite so practical as that presented in these pages some years ago on The Gas Turbine Power Plant by John I. Yellott, still it covers a great deal more ground, for it includes detailed discussion of theory, structural design, a good deal on aircraft types of gas turbines and so on. The book is one of the series in Mechanical Engineering now being edited by Burgess H. Jennings professor of mechanical engineering at Northwestern University Technological Institute. The author, Mr. Sorensen, is professor of mechanical engineering at the Institute of Technology, the State College of Washington.

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shop assembled power

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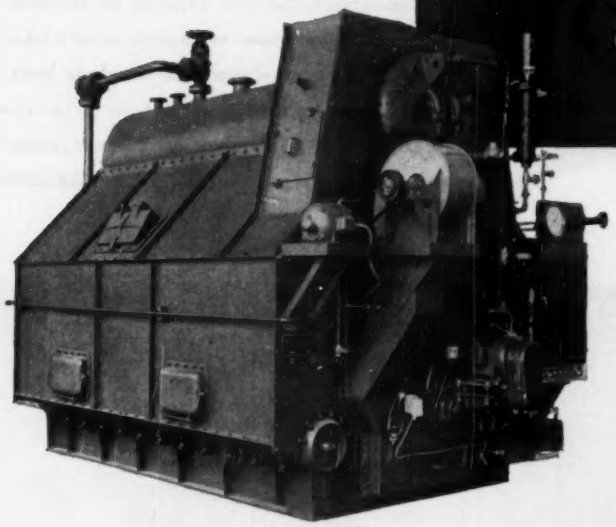

Steam power in a compact, efficient shop-assembled unit, custom-engineered to your exact steam generating requirements, ready for immediate installation! Wickes Type A Steam Generator is a steel-encased unit complete with baffles, refractories, pressure parts and firing equipment, designed to conserve headroom and floor space. Each furnace wall is a separate steam generator as well as an integral part of the boiler. There are no complicated headers or circulating tubes to require frequent maintenance or repair. Wickes Type A shop-assembled boilers are engineered for pressures up to 900 psi. with sustained steam production up to 35,000 lbs. per hour at 20 to 330 nominal h.p.

Wickes can also fill your requirements for steam generators up to 250,000 lbs. per hour and 950 psi. — all types of multiple drum boilers adaptable to any standard method of firing, oil, gas, single retort underfeed or spreader stoker. Write today for descriptive literature on Wickes complete line of steam generating equipment or consult your nearest Wickes representative.

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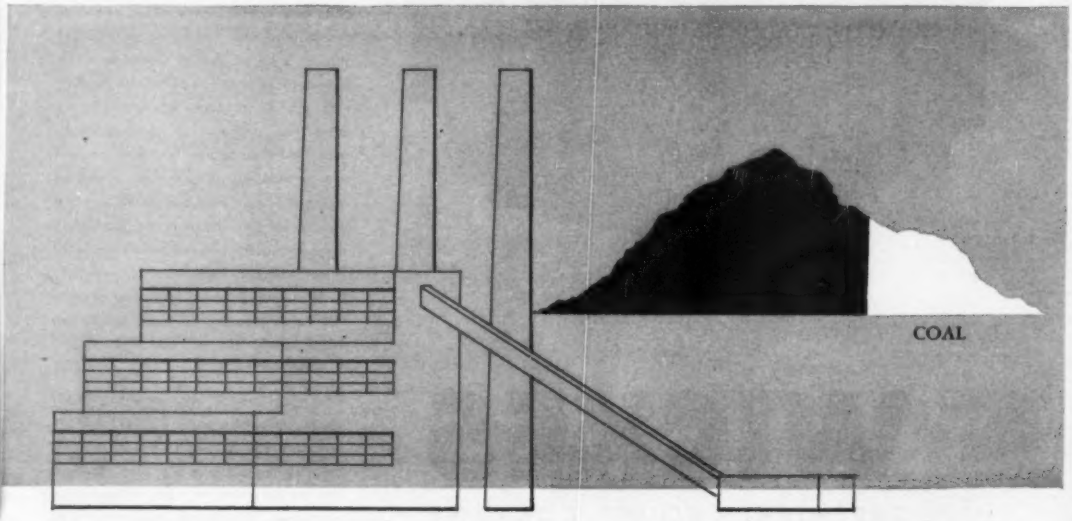
When you buy a combustion control system, the second best system is not good enough. No matter what it costs, it is too expensive. Too little air means unburned fuel, while too much air means heat wasted up the stack. Slight variations in either direction can, in a few years, cost more in wasted fuel than boilers and control systems together.

Hagan Automatic Combustion Control Systems are designed for *precise* control. When they are placed in service, they are adjusted by Hagan's experienced combustion engineers, who make sure that you *get* the precision which is built into the Hagan control system.

Hagan controls are used on every size of boiler from 5,000 pounds per hour at 3 psi. to 1,340,000



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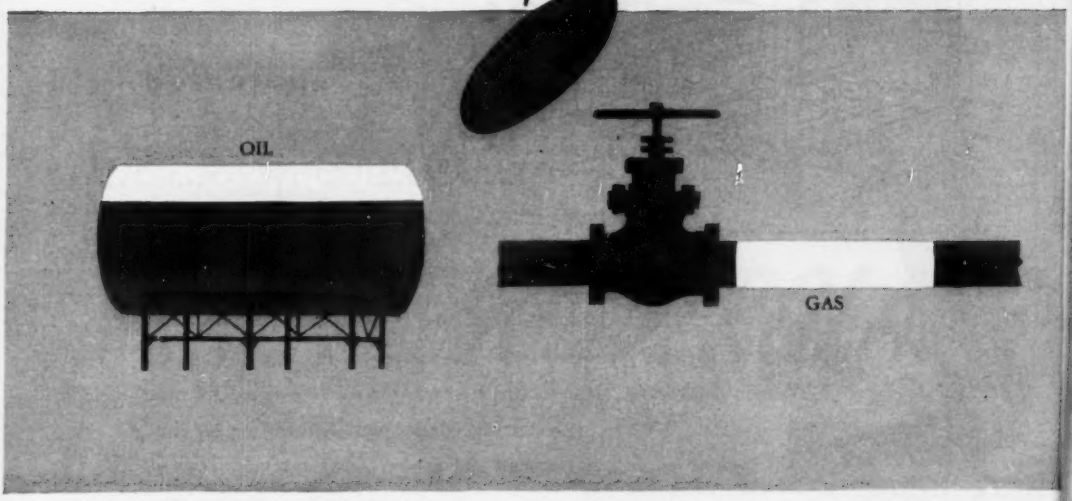
pounds per hour at 1800 psi. They have been applied to boilers burning oil, coal, gases of various types, even on boilers burning sawdust —and always with satisfactory results.

Our engineers will be glad to give you full information on Hagan control systems. Write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.



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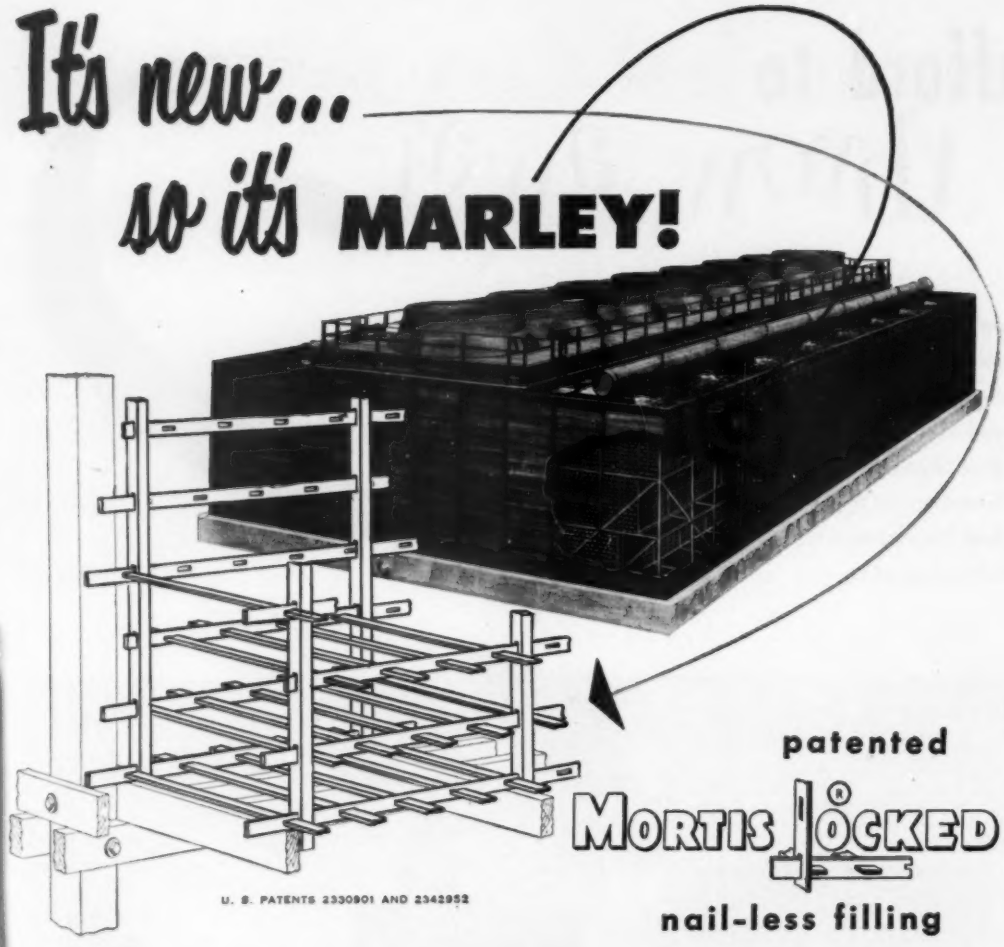

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The Marley Company, Inc.

KANSAS CITY 15, KANSAS

FAIRLESS STEEL WORKS

(*Continued from page 95*)

In the power house, auxiliary power will be supplied through two auxiliary power transformers and suitable switchgear. Generator excitation will be regulated by rotating-type regulators and a safety exciter will be provided capable of furnishing excitation to either generator. There will be six motor-control centers and three valve-control centers.

Boilers and Auxiliaries

The three boilers will be equipped with automatic feedwater control, superheat control and combustion control suitable for firing with blast furnace gas, coke-oven gas, natural gas, or fuel oil, either alone or in combination. They will have water-cooled hopper bottoms, arranged for a future pneumatic ash removal system if pulverized coal is required as an auxiliary fuel.

These steam generating units will each produce 300,000 lb of steam an hour at 885 psi, 900 F total steam temperature at the superheater outlet. A pressure-reducing and desuperheating station capable of handling the necessary quantities of auxiliary steam will be located in the power house.

Each boiler will be equipped with one forced-draft fan and two induced-draft fans. Each forced-draft fan will handle 451,000 lb of air an hour at 100 F and 17.9 in. H_2O. Each induced-draft fan will handle 461,400 lb of gas an hour at 620 F and 18.6 in. H_2O.

Water Supply

Water will be obtained from the Delaware River. Clarification and reduction of silica will be accomplished by the use of ferric sulphate and lime in two rapid-flow treatment tanks operating in parallel. Effluent from the tanks will go to four gravity filters operating in parallel. Filtered water will be stored in a 150,000-gal clearwell. From here it will be drawn to four parallel, gravity, zeolite-type softeners using styrene resin as the ion-exchange material. Softened water will be stored in a 75,000-gal soft-water clearwell. The plant is designed to treat 1,200 gpm.

There will be five boiler feed pumps with provision for another when a fourth boiler is installed. Each pump will have a design capacity of 333,000 lb per hr or 700 gpm. They will be centrifugal multi-stage, double-cased barrel types. Three will be turbine-driven and two dual-driven.

For simplicity of operation, stage feedwater heaters have been eliminated from the design. There will be two deaerating heaters, each with a capacity of 700,000 lb per hr and a normal operating pressure of 24.7 psia. One heater will handle feedwater to two boilers.

Condenser discharge water will be recirculated to the plant service water system by two 35,000,000-gpd centrif-

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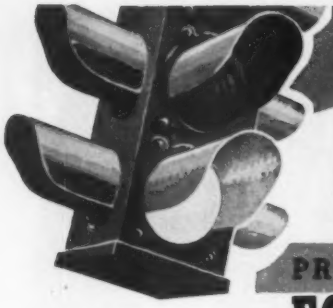
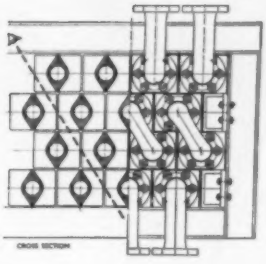


GREEN

PREMIER DIAMOND

ECONOMIZERS

The Economizer with the "Diamond" Design



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1...Streamline flow of flue gases gives minimum draft loss

2...Finned tubes give maximum heating surface in given space

3...Staggered tube arrangement permits easy inspection

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Green Premier Diamond Economizers are available in either cast iron tube construction (Type 25) or steel tube construction (Type 12).

Pressure parts are rugged and joint flanges independent of support flanges.

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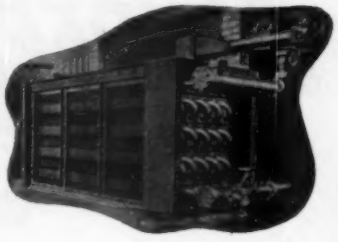

THE GREEN Fuel Economizer COMPANY INC.

BEACON 3, NEW YORK

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ugal, gear-turbine-driven pumps operating against a suction lift of 15 ft and a discharge pressure of 63 psi. This is equal to a total dynamic head of 160 ft.

Turbo-Blowers

The three horizontal turbo-blowers will each have a rated capacity of 110,000 cfm of standard air at 35 psi. They will be driven by horizontal, multi-stage steam turbines capable of developing full power capacity under steam from 800 to 850 psi, 850 to 925 F. There will be a volume regulator with automatic compensation for changes in barometric pressure and air temperature. An electric indicating and recording tachometer will be provided, as well as a cabinet-type panel board and complete lubricating system.

There will be three 10,400-sq ft condensers for the turbo-blowers, each equipped with one motor-driven and one turbine-driven condensate pump. The pumps will be 2-stage center-suction types.

Cooling water for these condensers will be provided by three horizontal, single-stage, double-suction, volute centrifugal turbine-driven pumps. They will deliver 11,200 gmp.

Provision is being made in the design of the power facilities at Fairless Works for oil storage tanks and for future addition of coal storage bunkers and pulverizers.

The power house building will be of steel frame construction, with 20-gage corrugated galvanized steel siding. The boiler room will be 221 ft by 116 ft, and the turbine room 224 ft by 117 ft. In addition to space provided for sanitary and locker room facilities, and office space, a radio transmitter room will be constructed on the roof of the boiler house. The turbine room will be 60 ft high, the boiler room 88 ft high and the boiler stack 146 ft high.

A 75-ton traveling bridge crane will be installed in the turbine bay. The building will be windowless and large doors will be motor-operated.

LOS ANGELES DEVELOPS OWENS RIVER HYDRO

THREE identical hydro plants, making use of a 2375-ft drop of water in the Owens River gorge in the High Sierra, will be a new source of power for the City of Los Angeles. Each plant will contain a 37,000-kw generating unit and all will be controlled from Plant No. 3, farthest downstream. A tunnel approximately 7 miles long carries water to the upper plant, which operates with 800 ft head. Another tunnel from afterbay of Plant No. 1 leads to No. 2 penstocks and another picks up the water from No. 2 and carries it to No. 3. A transmission line 260 miles long, operating at 230 kv, will transport the power to the city.

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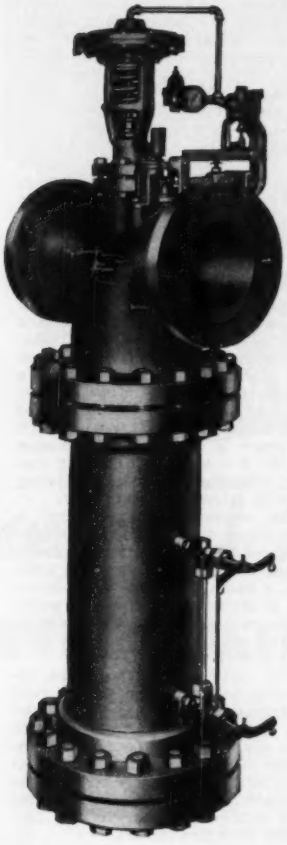
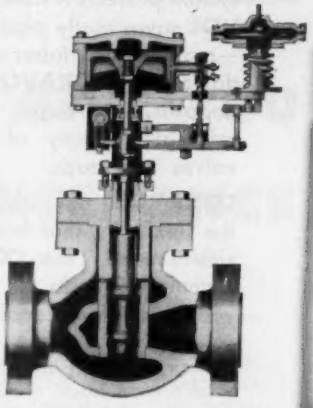


WHEN you select your pressure reducing and desuperheating station, you'll pay more if you buy COPES. But if your job is a tough one, you'll find COPES cheapest in the long run. You'll be money ahead in installation, operation and maintenance costs, and you'll be getting *accurate* control—even down to your lightest loads, not just at your normal flows.

You'll get *quiet* operation—avoiding annoying chatter and destructive vibration.

You'll get 'round-the-clock dependability for years to come—with any adjustments or maintenance easily handled by your plant personnel.

It all adds up to the kind of performance you need for your tough jobs—results you cannot expect if you buy on price.



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The COPES DESUPERHEATER

You'll find it easy to install the self-contained COPES Desuperheater. It goes into the line as a unit, with only three connections. All accessories are furnished. You need no extra steam atomizing valve with extra stop valves—no long run of alloy-steel steam piping—no extra piping from the temperature element to the spray nozzle—no other extras.

You'll also find your COPES Desuperheater correctly sized for low velocities—for minimum noise, vibration and wear. You'll find temperature control accurate—even on lightest flows—because cooling water is controlled and completely atomized inside the mixing chamber. Adjustment is simple and permanent.

The COPES REDUCING VALVE

You'll find your COPES valve ports accurately designed for the correct capacities under the flow and pressure conditions you specify. You'll have no "hunting" to upset the precision of your control.

You'll find extra-heavy construction throughout. The valve piston is supported and guided in the areas subject to greatest velocities and forces. If these forces could cause excessive erosion, Stellite is welded to all contact surfaces before they are precision-ground to correct clearance for your installation. You'll find design and construction minimizes the possibility of sticking, leaking or vibrating. You'll suffer no objectionable noise.

ENGINEERED BY THE MAKERS OF COPES FEED WATER REGULATORS

Steam

plus

CORAVOL

(The Original* AMINE PROCESS)

equals

Protection (FROM CORROSION)

Because CORAVOL Circulates to Control Corrosion

CORAVOL circulating throughout your steam system protects it from corrosive attack. **CORAVOL** saves costly pipe repairs and replacements—maintenance labor—hours and days of shutdown loss. **CORAVOL** cleans out clogging rust deposits, improving heat transfer, restoring original capacity of lines and efficiency of valves and traps.

CORAVOL, the original* amine process, has the flexibility that lets it conform to each individual need. The **CORAVOL** *you* will use is formulated to do the best protective job under your own plant conditions.

CORAVOL IS PART OF A COMPLETE TECHNICAL SERVICE which provides special chemical formulas for: boiler feed water . . . foam prevention . . . hot water supply . . . refrigerating brine . . . cooling and condenser water . . . rapid scale removal . . . coagulation . . . algae control . . . fuel oil supply . . . soot removal.

*The use of **CORAVOL** in steam systems is covered by U. S. Patent No. 2053024. The Western Chemical Co., owner of this patent, grants licenses under which volatile AMINES purchased from other sources may be used in steam systems upon payment of royalty to Western Chemical Co.

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BOKARO

(*Continued from page 98*)

take a breeching into a self-supporting steel stack 14 ft in diameter by 85 ft high.

Turbine Generator Equipment

For each unit system, steam is supplied from two boilers to a 50,000 kw, 0.85 pf, 58,824 kva, 3000 rpm turbo-generator. Each tandem compound, double flow turbine drives a 13,800 v, hydrogen-cooled (0.5 psig) generator, having direct connected, geared, main and pilot exciters arranged lengthwise along the turbine hall. The condensing turbine has 21 stages and is designed for 850 psig, 900 FTT steam at the throttle, and is provided with 5 extraction openings. Cooling water for the hydrogen coolers and turbine oil coolers is supplied from the station service system. Gland sealing water and water for bearing packing is supplied from an overhead condensate head tank. Each turbine exhausts to a 50,000 sq ft single pass, cross flow condenser equipped with divided water boxes and a built-in cross-over valve so that one-half the condenser may be cleaned while the other half is in service. Each condenser is designed to condense 327,880 lb of steam per hr when supplied with 50,000 gpm of circulating water at a temperature of 76 F.

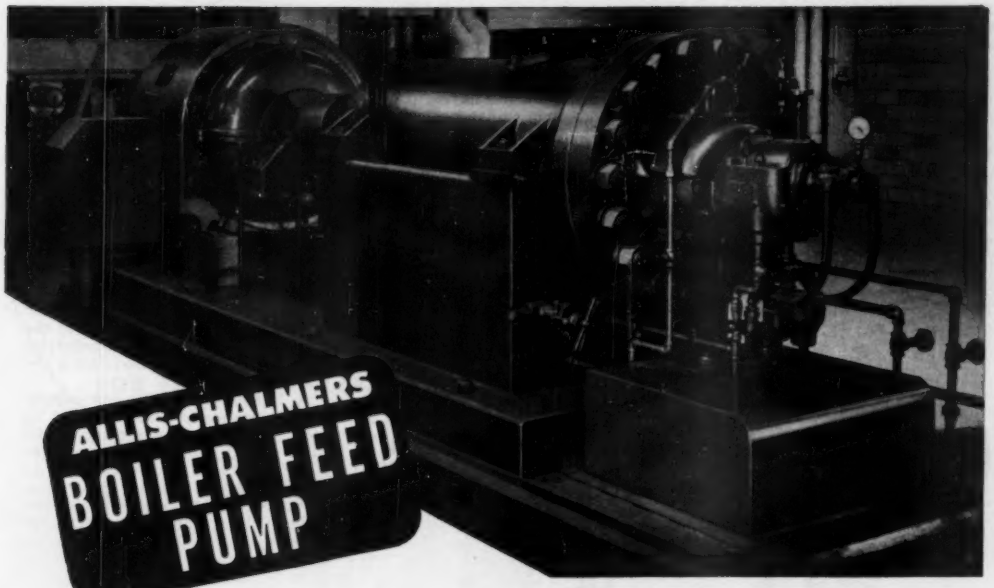
The condenser hotwell level is maintained by throttling the discharge of the condensate pumps with an automatic control valve. In addition, a hand controlled recirculation line is provided between the pump discharge header and the condenser hotwell so located as to insure sufficient flow through the ejector.

Two vertical mixed flow type circulating water pumps supply each condenser through two 36 in. cast iron pipes located in trenches flush with the basement floor. The condenser discharges through similar pipes into the discharge tunnel. The circulating water pumps are equipped with totally enclosed, vertical fan-cooled induction motors.

Feedwater Cycle

River water from the discharge tunnel is pumped to the water treatment building located at the southeast corner of the plant proper by either of two 300-gpm vertical raw water pumps. The water treatment coagulation and precipitation plant has a 300 gpm flow rate, at a surface rate not exceeding 1.0 gpm per sq ft and a retention time of not less than 90 min. Clarified water is uniformly decanted from multiple troughs and is collected in a concrete clear well adjacent to the rectangular precipitator basin.

Three 300 gpm coagulated water pumps are provided to pass the clear well water through the pressure filters and carbonaceous zeolite softeners to the concrete treated water storage tank. One pump will operate continuously, the second will start up



THESE 7 Features GIVE YOU RELIABILITY, LOW MAINTENANCE

1. Single stage, back-to-back impellers balance axial forces without use of balancing drum. Two impellers in first stage give advantages of double suction at this point.

2. Volute casing provides high efficiency and radial balance. Volute design also simplifies construction for easier maintenance.

3. Expansion joint is brought to outside of pump where leakage may be quickly detected and adjustments made without dismantling the pump. No flexible internal members are required for expansion compensation.

4. Packing is also located where it may be adjusted easily and quickly.

5. Uniform section of both inner and outer casings assures uniform expansion at all points. Expansion stresses are minimized; alignment is held.

6. Casing halves are held together with full hydraulic pressure of the pump assuring a tight seal with a minimum of heavy parts.

7. A carriage which may be attached to the pump body is furnished with each unit. The inner casing may be withdrawn from the outer casing on this carriage, making servicing easy and quick.

HERE IS A PUMP designed to meet the needs of the newer high pressure boiler plants. Efficiency is high, maintenance is low and every feature has a long record of successful application to boiler feed service.

Sizes range from 1200 to 2500 psig and from 300 to 2000 gpm. Allis-Chalmers can supply the complete boiler feed pump installation including pump, motor and control of coordinated design and manufacture.

Get the details on this new boiler feed pump from your Allis-Chalmers District Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3407

ALLIS-CHALMERS

automatically when the header pressure drops, and the third will be used as a spare.

Two 180 gpm treated water pumps supply the demands of the make-up deaerators and evaporator descaling systems. This water is also used for an emergency supply to the turbine packing head tanks.

The 4th, 8th and 16th stage closed feedwater heaters are supported vertically in the heater bay at the operating floor level. The 19th stage closed heater is supported horizontally at the stage heater platform 10 ft below the operating floor in the heater bay. Steam for feedwater heating is bled from the turbine at 5 extraction points. The 4th stage heater is equipped with a desuperheating section having a terminal difference of minus 3.2 F and an integral subcooling zone having a terminal difference of 10 F. The 8th stage heater is also equipped with desuperheating and subcooling zones having 0.7 and 10 F. terminal differences respectively. The 16th and 19th stage heaters each have 5 F terminal differences and are equipped with integral subcooling zones having terminal differences of 10 F. The drains from the 4th and 16th stage heaters are cascaded to the 8th and 19th stage heaters respectively, and in like manner, the drain of the 8th stage heater is cascaded to the deaerating heater and the 19th stage heater drain to the condenser hotwell.

Each unit feedwater system obtains its make-up in the form of steam from its single effect evaporator, which is supplied with water from the spray type make-up evaporator deaerator. The main deaerating heater is of the tray type with a feedwater compartment having a 10-min storage capacity.

The semi-barrel type boiler feed pumps are located at the basement floor and pump condensate from the deaerating heater through the 8th and 4th stage high-pressure heaters to the steam generating unit. Three motor-driven boiler feed pumps are provided for each unit or set of two boilers, one pump for each boiler with one to act as a standby. Automatic boiler feed pump recirculation to the deaerating heater is provided, thereby affording pump protection during the low load operation.

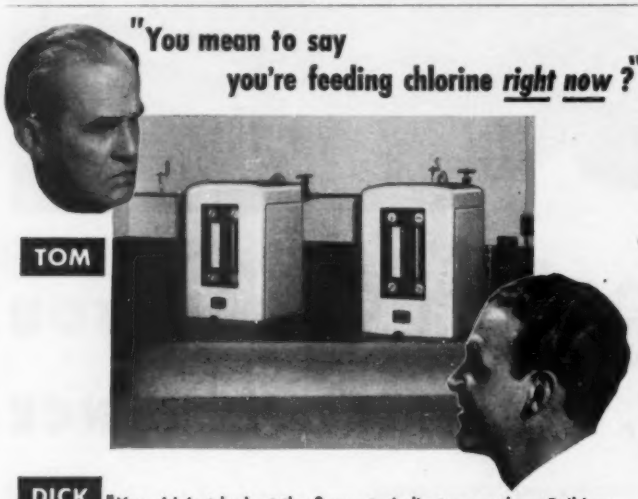
A 17,000 gal condensate supply tank is connected with the inlet to each unit deaerating heater. A low water level in the deaerating heater will cause the line control valve to open, thereby operating a pressure switch which energizes either of the motor-driven condensate transfer pumps, allowing condensate to be pumped from the condensate supply tank to the deaerating heater. The pump is de-energized automatically when the deaerator level and line pressure is re-established. In addition, one 150,000-gal, 30-ft-diameter outside storage tank is provided as an emergency source of condensate for the unit condensate supply tanks. The condensate level in the storage tank will be maintained to allow ample space to store feedwater drained from any two boilers during an emergency shut-down. A condensate storage transfer pump is provided to transfer the condensate from the common header and interconnecting piping to the outside storage tank.

General Equipment

At present 3 station service pumps, each having a capacity of 3500 gpm, will be provided. One pump will be installed in each of the screen pits. The pumps are sized so that any two will carry the demands of 3 turbine generators and 6 steam generating units. This arrangement not only provides a standby pump but provides for dewatering of the screen pits.

The drinking water and water for sanitary facilities will be supplied from the village nearby to the fresh water storage tank provided in the water treatment building. The tank will be equipped with 3 motor-driven pressure pumps, two of which will be operated by header pressure switches and the other will serve as a standby unit.

A complete plant and yard fire control system is provided. This includes a plant and yard water system for fogging nozzle use only, carbon-dioxide units of 15, 25, 75 and 100 pound capacities, a fire alarm station system for plant and yard, and an automatic alarm head system for


"You mean to say you're feeding chlorine right now?"
TOM
DICK "Yes, sir! Just look at the flow rate indicators on these Builders Chlorinizers. When they show a chlorine flow, you can be sure chlorine actually is being fed. Incidentally, why do you ask?"
TOM "Well, I always thought chlorine odors and corrosive fumes were a necessary evil in any chlorinator room. How come I don't smell chlorine in here?"
DICK "We've discovered that Builders Chlorinizers never give off chlorine odors in operation. You see, fresh water is continuously supplied to the tray, drawn into the injector with the chlorine gas, and delivered to the point of application. You can't get tray-produced odors with Chlorinizers in your plant!"
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FOR ANY CHLORINATION SERVICE
If you're like Doubting Tom, now's the time to find out more about Builders Visible Flow Chlorinizers. Available in three volumetric models . . . for any chlorination service:
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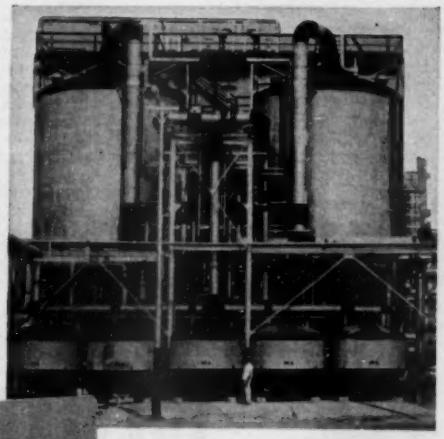
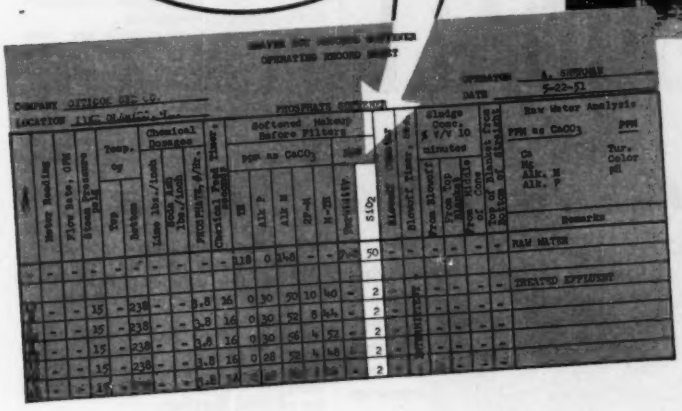
Silica Reduced from 50 ppm to 2 ppm

FOR 900 psig BOILERS





OPERATING RECORD SHEET

OPERATOR A. SIMPSON

DATE 5-22-51

Water Reading, GPM	Flow Rate, GPM	Steam Pressure PSIG	Temp. °F Top	Temp. °F Bottom	Chemical Dosages Lime lbs./1000	Chemical Dosages Soda Ash lbs./1000	Chemical Feed Timer Setting	PHOSPHATE, #/hr.	Softened Makeup Before Filters PPM as $CaCO_3$ M	Alk. P	Alk. M	ZP-M	M-ZH	Hardness	SiO_2	Blowoff Timer, Sec.	Blowoff	Sludge Conc. % V/V 10 minutes From Top	Sludge Conc. % V/V 10 minutes From Cone	Top of Blanket From Bottom of Blanket	Remarks
-	-	-	-	-	-	-	-	-	118	0	236	-	-	236	50	-	-	-	-	-	RAW WATER
-	-	15	-	238	-	-	3.8	36	0	30	50	10	46	-	2			-	-	-	TREATED EFFLUENT
-	-	15	-	238	-	-	3.8	16	0	30	52	8	44	-	2			-	-	-	
-	-	15	-	238	-	-	3.8	16	0	30	56	4	52	-	2			-	-	-	
-	-	15	-	238	-	-	3.8	16	0	28	52	4	48	-	2			-	-	-	
-	-	15	-	[illegible]	-	-	3.8	16	[illegible]					-	2			-	-	-	

Raw Water Analysis

PPM as $CaCO_3$ PPM

Cl
Mg
Alk. M
Alk. P
Tur.
Color
pH

by GRAVER Hot Process Softeners

All hot process softeners aim to reduce silica by using magnesium compounds present in or added to the water being treated.

But here's why the GRAVER Softener does the job so much better than other designs. The first reason is *intimate* contact . . . the water is passed through a deep dense bed of sludge containing the silica-removing magnesium compounds. The second reason is *prolonged* contact . . . the GRAVER design makes the water pass *slowly* through the sludge bed.

The above actual operating record of a GRAVER Hot Process Softener installation shows the effectiveness of the GRAVER design in reducing silica from a high amount down to an amount suitable even for high-pressure boilers, while reducing total hardness from 118 ppm to zero.

No matter what may be *your* particular water softening problem, you can get similarly effective results from a GRAVER installation, because GRAVER manufactures equipment for *every* water conditioning process, with authoritative selection and modern designs based on more than 40 years of specialized experience.

Write for advice on *your* water conditioning problem, and for information on GRAVER designs . . . there's no obligation.

GRAVER WATER CONDITIONING CO.

Division of Graver Tank & Mfg. Co., Inc.

216 WEST 14th STREET, NEW YORK 11, N. Y.

GRAVER

GW-410

vital locations. The dual drives of the 1000-gpm, 150 psig vertical fire pump are electric motor and gasoline engine.

Architectural and Structural Features

The main building dimensions are approximately 170 by 450 ft. The turbo-generator bay, 46 ft wide, is provided with a 125 ton overhead crane. The heater bay is provided with a 25 ton overhead crane.

The electrical bay is 24 ft wide and the front portion of this bay on mezzanine floor is provided with various offices for supervising personnel. The main roof of building is 118 ft high above basement floor and the 4 self-supporting steel stacks, 85 ft high, are supported on main roof steel girders. The entire structure is of structural steel to sustain all loadings including the forces set up by wind and possible earthquake action. The main operating floor is reinforced concrete slab; the upper floors and platforms of metal gratings are removable as required. The 4 turbine generator foundations are of reinforced concrete, entirely independent of the building structure. The length of the building and the temperature differential of 85 F necessitated a continuous expansion joint through the building.

The main stairs, as well as the adjacent passenger and freight elevator, serve all necessary floor levels.

On outside of building a 15 ton gantry crane with a 40 ft span has been provided, with the crane runway extending 360 ft. Considering the torrential rains during the monsoon season, the rain water conductors range from 4 to 15 inches in size.

Lavatory arrangements meet the native personnel requirements.

It is interesting to note that on the East wall area 50 ft high and running the length of the building, the local authorities decided to commemorate the history of the local inhabitants in a series of murals.

Editor's note: This concludes the description of the general and mechanical features of Bokaro Station. The electrical features will be described in subsequent issues.

Check the Advantages of

GOODALL Rubber EXPANSION JOINTS

THREE TYPES — "Flang-Lok," Right-Angle and Sleeve

FIVE STYLES — Single Arch, Multiple Arch, Tapered, Offset and Rectangular

ALL SIZES — From ⅜" I.D. to 96" I.D.

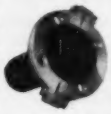
For Pressure, Vacuum or Both

Every factor involved in the building of Goodall Expansion Joints contributes to maximum efficiency, durability and safety under all service conditions. Specifications for their component parts are dictated by long experience in making these products; and factory specialists apply their skill to every detail of construction.

Uses: To eliminate the costly effects of expansion and contraction in metal pipe lines and other equipment; to counteract vibration; to insulate against undesirable sound; and to correct for misalignment. Under pressure, vacuum or both, they will withstand repeated flexing, with highest resistance to cracking and "setting."

GOODALL *Rubber* EXPANSION JOINTS are used for handling water, air, oil, brine, acids, alkalies, gases, gasoline, refrigerants, tar, molasses and many other substances, at temperatures up to 250°F. Construction determined by service requirements.

ADVANTAGES OF "FLANG-LOK"



The combination of "Flang-Lok" End Expansion Joints and "Flang-Lok" Floating Flanges assures quick, easy installation even in extremely "close quarters." It is only necessary to turn the flange (not joint or pipe) to align bolt holes with connecting flange. As flange bolts are tightened, rubber end of joint is compressed over a broad area of connecting flange, providing a leak-proof seal having the widest margin of safety against rated pressures.

Contact Our Nearest Branch or Write for New Booklet

GOODALL RUBBER COMPANY

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

Branches: Philadelphia · New York · Boston · Pittsburgh · Chicago · Detroit · St. Paul · Los Angeles · San Francisco · Seattle · Portland · Salt Lake City · Denver · Houston · Distributors in Other Principal Cities

Est. 1870

AIR CONDENSES STEAM

(*Continued from page 69*)

pacity of 8555 lb per hr of water vapor. These vapors are condensed in the steam condensers.

The boiler feed pumps are two-stage centrifugal type, driven by turbines discharging against 75 psig back pressure. The discharge water passes through a preheater, then through a level-control valve to the boilers, with a take-off to provide make-up for the gas-engine jacket-cooling water.

The boilers provide approximately 20,000 lb per hr of steam directly to the turbine generators. The remainder of the steam passes through exchangers, which heat the regenerating gas for the dehydrators. It loses about 10 deg temperature here. It then passes to the boiler feed, lean oil and monoethanolamine turbines, all of which exhaust against 75 psig pressure. The 75-psig steam is then used for recriprocating pumps and for process purposes.

The electrical generating facilities consist of two 1875-kva Westinghouse 440-v, 3-phase, 60-cycle generators, driven by condensing turbines designed for the following operating conditions:

Steam pressure at throttle flange	245 psig
Back pressure at exhaust flange	3.5 psia
Steam temperature, normal	600 F
Steam temperature, maximum	700 F

Either of the generators is more than capable of handling the plant load but both are operated continuously, since current failure shuts down the entire plant and several hours are then required to return to normal operation, even if no appreciable damage occurs.

The steam condensers are the Hudson horizontal type and were designed to have a total condensing capacity of 28,000 lb per hr of vapors at an absolute pressure of 3 psi and 141 F temperature and with an ambient air temperature of 95 F. It consists of four units, each having two bundles containing 195 finned tubes

Minimum Span, Oversize Casing Studs
Proof against cutting between stages depends on uniform pressure on gasket. On Warren TH Pumps, extra heavy bolting is especially close to channel rings and bolts are spaced and oversized to provide uniform pressure and lock flanges together for maximum strength. (Inner bolts 1¾", outer bolts 1½")

Locked Channel and Case Rings . . .
Inter-stage seals or channel rings are not only wide to reduce by-passing between stages to minimum, but to make it possible to place casing bolts close to rings for maximum and uniform pressure on gasket. Double flange in lower half and single flange in upper half assures secure locking of channel and casing rings.

Genuine Kingsbury Thrust Bearing
Made by Kingsbury Machine Works, not modified type of other make. Oil cooled, heavy duty, duplex ball thrust bearing available and practical for discharge pressures 800 p. s. i. and lower.

"Undercover" facts—

why WARREN six stage, type TH high pressure boiler feed pumps are a most dependable investment.....

There are many other important factors designed to provide a sound investment over the years. Evaluate the benefits and contact Warren on your next high pressure boiler feed job. Write for Bulletin 244 giving further details.

P-25

Trouble-Free Solid Discharge Nozzle
Discharge nozzle is flared and extra heavy, with studs, instead of the conventional flanged type nozzle, thus eliminating danger of breakage.

Extra Heavy Casing Flanges . . . .
To provide freedom from warping, casing flanges are not only extra heavy but each bolting point is backed up with heavy boss, providing highest possible strength.

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC., WARREN MASSACHUSETTS

Less "Elbow Grease" Needed Because

DARTS

are DROP-TIGHT!

This True Ball Joint Makes the Difference

You don't have to be a "muscle man" to tighten a Dart — they're drop-tight without excessive wrenching. That's one reason why they can be used over and over again.

Darts *last longer* because both seats are non-corrosive bronze for resilience and peak protection against corrosion and pitting. What's more, both seats are *precision machined* then *spherically ground* to a true ball joint.

Last, the nut and both ends of a Dart are *practically indestructible.* They're made from high test, air-refined malleable iron.

Because they're grief-proof in the jobs they do — Darts are grief-proof for the dealers who handle them!

DART UNION COMPANY
Providence 3, Rhode Island
The Fairbanks Co.— Distributors
Boston New York Pittsburgh

DART
UNIONS

each. All bundles operate in parallel.

The four-bladed induced-draft fans are mounted horizontally on top of the unit and have the adjustable-pitch feature. They are 14 ft in diameter. The stainless-steel blades are protected by hail guards strong enough to prevent a man from falling into the blades.

The fans are driven by a two-speed, 3-phase, 400-v motor. Full speed requires 25 hp and half speed 6¼ hp. The motor is coupled horizontally to a geared speed reducer; and the gear box, immediately under the structure, is coupled to the fans by a vertical shaft extending through the tube bundles.

Final condensing is provided by a jet condenser at the condensate receiver tank. This vessel is also equipped with an atmospheric jet for use during plant start-up periods. Centrifugal pumps take suction from receiver and pump through the coils after the jet condenser to the deaerating heater.

The steam condensers have operated very satisfactorily even with ambient temperatures of 107 F. As the air temperature drops, less air flow is required and the fans are operated at half speed, or cut out entirely, with a consequent decrease in generator load. In two years of operation, no failures have occurred in the tube bundles, the fan blades, or the gear boxes. They require a lubrication check once per week.

PUMPED STORAGE

(*Continued from page 78*)

under Plan 8, the same five dams built for Plan 1 as constructed for Plan 8, but including a smaller power installation, are estimated to cost $35,376,001. Annual costs at 9.26 per cent would amount to $3,276,821.

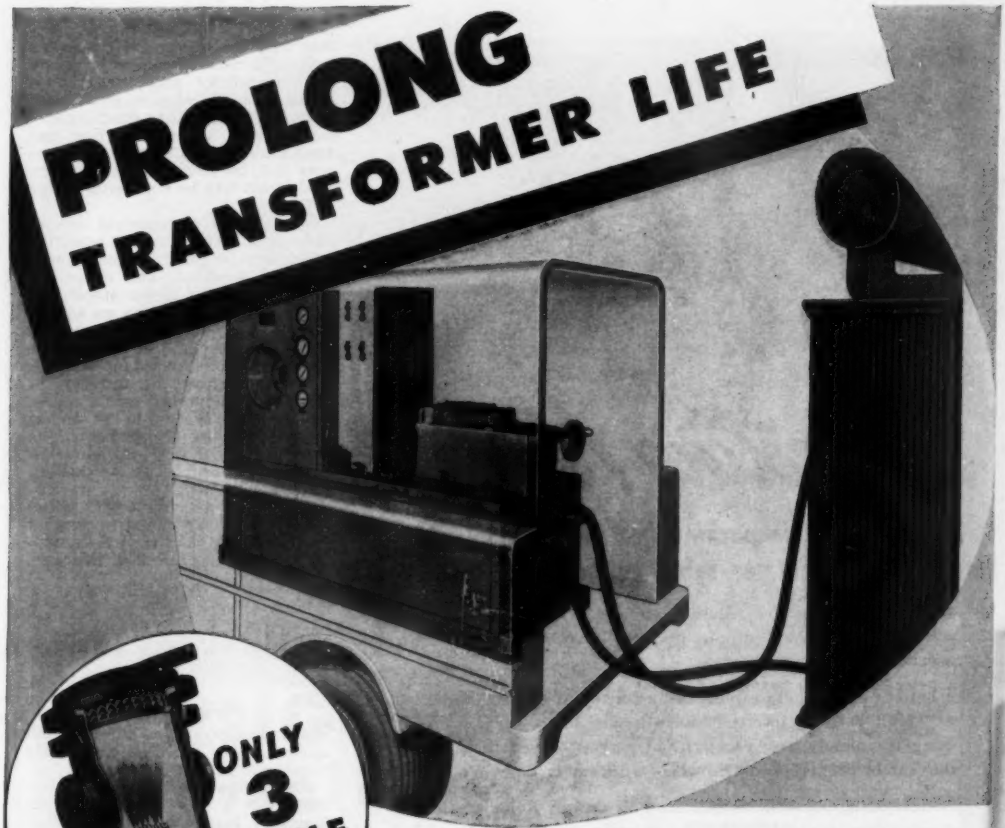
Under this Plan 1, these five plants would have a total dependable capacity of 65,000 kw and 256,000,000 kwh of average annual energy. At the same rates for capacity and with an energy value of 1.13 mills per kwh at the market, the power benefit would be 1,894,418 or an economic ratio of benefits to cost of 0.578 to 1.0. To pay the annual charges alone the power would have to sell for 12.80 mills per kwh.

Pumped Storage Wins

There is the comparison: The same dam, the same water, more power produced in one than the other; the cost of $227.29 per kw of installed capacity, for delivery at the market for Plan 8, as compared to $600 per kw for Plan 1. In addition, is the benefit to the steam system from pumped storage. The steam system load factor is improved and plant operation made more efficient.

A summary and comments are given in the complete article on the general benefits of pumped storage, amplifying the comments given at the beginning of the article. One

PROLONG TRANSFORMER LIFE



ONLY 3 SIMPLE STEPS

1. The Bowser method atomizes oil into minute particles to expose maximum surface area.
2. Volatile contaminants are then completely removed by high vacuum.
3. Dry colloidal particles are removed by microfiltration.

. . . by periodically treating transformer oil with Bowser insulating oil conditioners.

A survey of thirty utilities, continuously using this method of preventive maintenance for six years, revealed *not one transformer failure due to contaminated oil!* Transformers remained energized while the insulating oil was processed.

Best of all, this method eliminated replacement of insulating oil as well as its removal to a central point for reclamation with fullers earth or chemical treatment.

LOW COST—HIGH DIELECTRIC

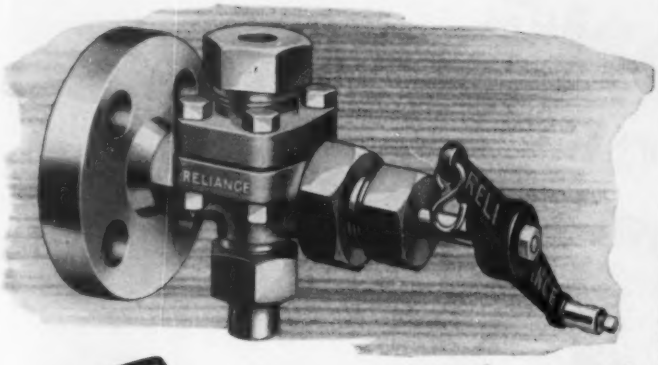
The average cost of preventive maintenance was less than one cent per gallon per year. Oil dielectric was kept above 35 k.v. with a single pass, and the water soluble acid content was nearly zero.

NOW is the time to reduce your maintenance costs!
Write today for all the facts on Bowser conditioners.

BOWSER ENGINEERED 1885

BOWSER, INC., 1351 CREIGHTON AVE.
FORT WAYNE 2, INDIANA

LIQUID CONTROL SPECIALISTS SINCE 1885



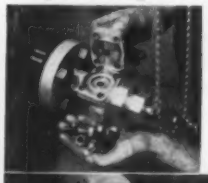
Exciting News!

Reliance *removable packing box* water gage valve—latest development for safer, better gage maintenance

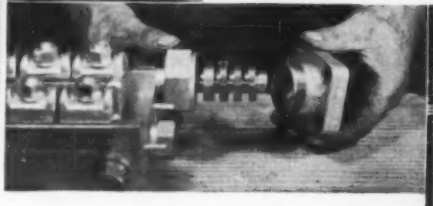
● This new-type valve reduces time spent near the drum—lets you take inserts and nipple packing boxes down for *bench convenience* servicing.

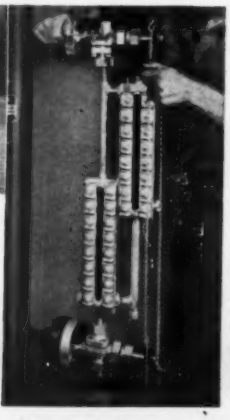
A better packing job prevents steam-cutting of nipples on expensive high pressure inserts. Assure longer insert life by always using completely *new* packing and gaskets. With these valves they can be properly installed where work can be done in comfort.

A heavy-duty valve of forged steel in typical Reliance rugged construction, available in flanged or screw connection. Good for pressures up to 900 psi. Profitable to use for power boiler service or oil, ammonia, Dowtherm, acids. Highly praised by engineers who have installed them. Write for catalog page B2.3.



THE RELIANCE GAUGE COLUMN COMPANY
5902 CARNEGIE AVE., CLEVELAND 3, OHIO





Reliance makes a complete line of Water Columns, Water Gages and other trim for all working steam pressures.

Since 1884
Reliance®
BOILER SAFETY DEVICES

point is that pumped storage projects may not necessarily conserve fuel, since more off-peak energy may be required for pumping than is obtained during on-peak generation. However, by making practicable a project that has natural flow and head available and that would otherwise not be developed at all, the final result may be a material saving in fuel.

In the field of improved design, the author points out that attention could well be given to the 2-speed electrical machine, one speed for generating and a higher speed as a motor for pumping. Also, an adjustable blade modified Kaplan-type runner might be designed so that the blades could be reversed for pumping without changing the direction of rotation of the unit. It would appear that the bottleneck in advancing pumped storage design lies in an inadequate electrical machine capable of furnishing two satisfactory speeds.

The study concludes with a detailed discussion of points to consider in determining the size of the pump-turbine unit for projects of this type.

Obituaries

Alfred G. York

AFTER a prolonged illness, death came today to Alfred G. York at his home in Elizabeth, New Jersey.

Mr. York was a Director and Vice-President of the Watson-Stillman Company, Roselle, New Jersey, where his record of achievement was outstanding.

Shortly after joining the Watson-Stillman Company in 1918 he became Assistant Treasurer — a position he held until his promotion as Assistant to the President.

In 1941 he was elected Vice-President and General Sales Manager of the Company. In 1945 Mr. York was elected to the Board of Directors, at which time he took full charge of the Distributor Products Division.

HELPFUL BULLETINS

(*Continued from page 46*)

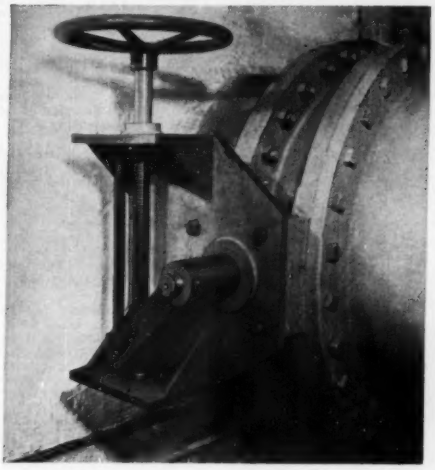
127 General Service Pumps— The pumps described in Bulletin 48-28-300, 12 pp, are moderately priced, horizontal, single-stage end suction centrifugal pumps. Gives specifications, dimensional data for standard pumps and those designed for handling gasoline, butane, diesel fuel, other inflammable hydrocarbons. Byron Jackson Co.

VALVES, TRAPS AND PIPING ACCESSORIES

128 Steam Trap Selector— Bulletin T-1750 is a 20-pp supplement to company's Catalog T-1740 released earlier, and contains excellent selection data. Applications, listed alphabetically, cover traps for uses from acid vats to vulcanizers, also traps for kitchen, laundry and special equipment. Provides full capacity, pressure and temperature information, installation tips. Yarnall-Waring Co.

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



RUGGED Simplicity

Correctly engineered mechanically and metallurgically, all body assemblies of R-S Valves equal or exceed A. S. A. standards in every detail. These valves are designed and constructed for rugged service and provided with such safety factors that they will exceed service expectations as well as reduce pumping and blower costs.

Consider also the few working parts, greater control rangeability, the self-cleaning feature and the fact that R-S Valves are readily adapted to automatic operation. Know the rugged simplicity of R-S Valves, and get the most from your valve investment.

District offices are listed in telephone directories as, "R-S Products Corp'n Valves".

R-S PRODUCTS CORPORATION
4600 Germantown Avenue, Philadelphia 44, Pa.
An S. Morgan Smith Company Subsidiary

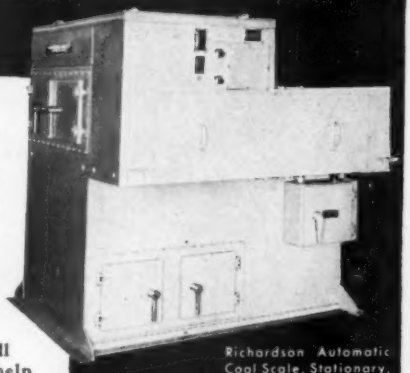
R-S VALVES
Simplify the Control
and Shut-off
of Volume and Pressure
from 2 to 2500 psig
Write for Catalogs 17 and 18

No. 739-740—Sixty-inch, 50-pound Heavy Duty Valve with gear reduction drive and handwheel for handling water at 40 psig. Vertical valve stem enclosed in steel pipe support. Thrust bearing absorbs vertical load.

No. 730—R-S Heavy Duty Floor Stand for rugged service in connection with any standard R-S handwheel operated valve.

No. 767—A 3-Way Valve (Two 24-inch 125-pound Cast Iron Valves bolted to 125-pound American Standard Tee). Electric motor operated by cross linkage. Automatic declutching handwheel for emergency operation.

KEEP YOUR B.E. UP
YOUR COAL COSTS DOWN...



Richardson Automatic Coal Scale, Stationary, Floor Mounted Style.

1 **Richardson Coal Scales**—Low B. E. (boiler efficiency) and costly coal waste are quickly signalled, the moment they begin, when you install a Richardson Coal Scale over each boiler. You get a detailed record of coal consumption by the hour, shift, day, week or month. By checking on all forms of coal waste they help to keep your power costs at a minimum!

Richardson "MONORATE" Distributor showing patented curved plate which prevents separation of lumps and fines.

2 **Richardson "Monorate" Distributors**—Designed by Richardson engineers for preventing coal segregation in stoker fired installations, the curved top plate of the "Monorate," causes all coal, *lumps and fines*, to fall at the same rate. It eliminates the tendency for the mixture to separate. This insures a uniform spread over your stoker hopper . . . a prerequisite for efficient combustion.

A complete Richardson Installation Provides:
Leakproof Gate from the bunker, Flexible Inlet to scale, Automatic Coal Scale, "Monorate" Non-Segregating Distributor to stoker or Down-take Chute to pulverizer.

Richardson engineers will be glad to discuss your coal consumption problems. For complete details on Richardson Coal Scales write for Bulletin No. 1143. Bulletin No. 1349-P gives complete information on the "Monorate."

CLIFTON, NEW JERSEY

Atlanta • Boston • Buffalo • Chicago • Minneapolis • Wichita
New York • Omaha • Philadelphia • San Francisco • Houston
Montreal • Toronto • Cincinnati • Detroit • Pittsburgh

Richardson

Materials handling by weight

6363

129 **Purifier Catalog** — Illustrated and described in Bulletin G-51 are nine types of purifiers for entrainment separation in air, steam, vapor and gas applications. Also described is company's method of employing centrifugal and centripetal forces to obtain highest separation efficiency without moving parts or mechanical filters. The Centrifix Corp.

130 **Improved Vapor Purifier** — An internal type purifier designed to remove virtually all entrainment from vapor is described in Condensed Bulletin 100. Advantages described include delivery of vapor with 1 ppm or less of total solids, low initial cost, elimination of baffling, self cleaning action, low pressure drop. Bulletin provides cutaway drawing showing flow of vapor through unit, table of dimensions, specifications and explanation of how unit works. The V. D. Anderson Co.

131 **Revised Valve Data** — Important revisions in manufacturer's Catalog 100-4 on air control valves are available. These affect light-duty 2-position 4-way valves and 3-way valves and poppet-type hand control valves. The revised pages provide up-to-date engineering data, information, illustrations and dimensional drawings on additional models plus changes in model numbers. Logansport Machine Co., Inc.

132 **Insulation for Piping** — "Foamglas Insulation for Piping and Process Equipment" is a 24-pp illustrated booklet discussing advantages of Foamglas. Lists properties; gives typical data for cold, intermediate and hot applications; details for insulating tanks, ducts, removable covers and tank heads, accessory materials. Tables show sizes and shapes available in pipe insulation, standard blocks, beveled lags and standard curved segments, also recommended shapes and thicknesses. Pittsburgh Corning Corp.

MAINTENANCE

133 **Quick Cure for Sick Floors** — Bulletin 200 is an 8-pp instructive booklet offering information on how and where to apply Plastic Rock flooring as well as technical data about the product itself. Typical flooring applications for this heavy-duty surfacing material are illustrated to show how new life can be given to old floors. United Laboratories, Inc.

134 **Turbine Oil Conditioning** — Twelve-pp Bulletin 832-P, 12 pp, describes and illustrates dry-type oil maintenance methods for bearings of modern turbines. Importance of continuous oil maintenance, and the factors which cause turbine oil deterioration are explained by charts, diagrams and phantom views. Various maintenance systems are shown with capacities and dimensions. Also presented is a system for maintaining insulating oil dielectric in transformers, circuit breakers, switches. Bowser, Inc.

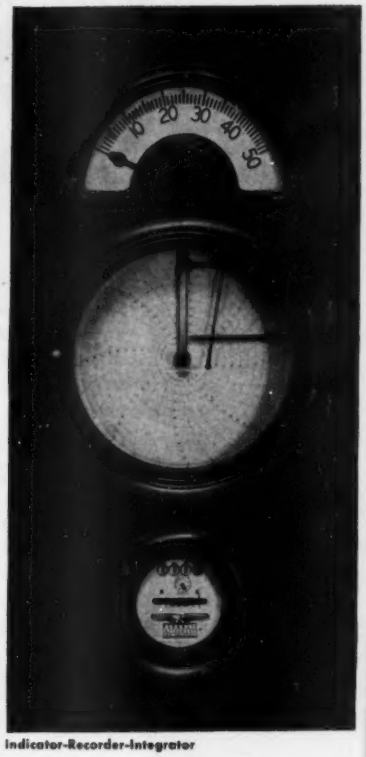
BOILER ACCESSORIES

135 **For All Tube Cleaning** — Company's ball-bearing motor and optional cleaning heads for different types of tubes are described in Bulletin 49. Dimensional data included. The Airetool Mfg. Co.

136 **More About Safety Devices** — Form SC-1 is company's new 20-pp supplemental catalog covering products not listed in condensed catalog issued a few months ago and featuring most widely used safety devices for steam and hot water boilers. The new book presents products for special applications, boiler and make-up water feeders, low water fuel cut-offs, float valves and other equipment. Contains interesting facts about liquid level controls and related devices, data valuable in solving special boiler water level control, liquid level control and relief valve problems. McDonnell & Miller, Inc.

Integrator

Varying flows are accurately totalized because the integrator is continuous



Indicator-Recorder-Integrator

The Republic flow integrator, being of the modified watt-hour type, totalizes continuously—not intermittently. It operates independently of the recorder and its accuracy is not dependent on or affected by any clock mechanism or mechanical action.

The Republic meter is, on this account, peculiarly fitted to follow all changes in flow rate and accurately measure highly fluctuating flows.

ALL TYPES OF FLUIDS

Republic electric type flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures up to 5,000 lb. per sq. in. and for all ranges of differential pressure. The reading instruments—indicator, recorder and integrator—are of the remote reading type and can be located any distance from the point of flow measurement.

ANY COMBINATION

While each Republic reading instrument is standard in design and construction each is especially calibrated for the particular flow measurement for which it is specified. Any reading instrument, indicator, recorder or integrator, may be obtained separately or in any combination desired, making possible the highest degree of flexibility in plant use.

SIMPLE IN OPERATION

The Republic electric meter is the only flow meter commercially manufactured which is strictly electric in its operation. All other types of so called electric meters use the motion of the mercury to move a float or produce a force which is then converted into an electrical value which is in turn transmitted to a receiving or reading instrument. In the Republic meter, the transmitted electrical value is determined directly by the mercury motion, thus eliminating one of the steps in the sequence, and simplifying the mechanism to that extent. There are no floats, levers, cams, rotating shafts or anything else to interfere with the unimpeded movement of the mercury, which has no work to perform, but merely fulfills the function of making contact.

NEW DATA BOOK

Just off the press—a completely new data book describing and illustrating, in detail, the operating features of the Republic Flow Meter and its many applications. Write for your copy of Data Book No. 702—there is no obligation.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

Treat Cooling Water *with Chlorine* — the Proven Way

HELP MAINTAIN MAXIMUM PLANT EFFICIENCY..

Hundreds of power plants and refineries have found chlorination by W&T the answer to heat exchanger slime problems. By eliminating slime forming microorganisms, maximum heat transfer is maintained in the condensers. The result — overall plant efficiency is kept at a maximum.

REDUCE LABOR COSTS...

High labor costs involved in frequent condenser tube cleaning are eliminated when chlorination is employed. Manhours used for tube cleaning can be utilized for other maintenance jobs, an important factor with the increasing manpower shortage.

REDUCE DOWN TIME...

Elimination of frequent shut-down for tube cleaning helps power plants stay continuously "on the line." When chlorination is employed, many plants find that outage for cleaning is reduced to once per year and then only for removing trash from tube sheets.

W & T Air Operated Visible Vacuum Chlorinator

Years of operation have proved the dependability and accuracy of W&T Chlorinators for cooling water treatment. Low maintenance and automatic program operation keep operating costs to a minimum. Your W&T Engineer is prepared to make a survey of your plant to recommend the proper chlorination equipment. Write today for more information on slime control — no obligation, of course.

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CHLORINE AND CHEMICAL CONTROL EQUIPMENT

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METALS

137 Selection Guide for Engineering Irons — This 28-pp basic reference booklet presents the many valuable characteristics of modern nickel cast irons. Fifty illustrations indicate wide industrial usage in all sizes and shapes, and 27 tables, charts and microphotos show how through the use of nickel, alone or in combination with other alloying elements, the engineering properties of cast iron can be controlled to meet almost any reasonable combination of service requirements. Covers fully the mechanical and physical properties of modern alloyed irons, includes specifications for typical applications. The International Nickel Co., Inc.

138 Using Alloy Steel Tubing — Assistance in solving problems involving use of alternate grades of low carbon, or carburizing grades of tubing steels is offered in Bulletin TDC 149. Presents condensed data on microstructure, critical points, effect of alloy elements, forging, machining, welding and thermal treatment for 14 well-known alloy steels used in the production of tubular parts. The Babcock & Wilcox Tube Co.

139 Stainless Steel Handbook — To fill the need for more complete on-the-job reference data, company's previous edition has been completely rewritten and more information provided. In its 120 pp this cloth-bound text describes some 40 types of stainless steel from standpoints of analysis, fabrication, heat treatment and special service conditions. The opening chapter includes selector table covering 30 types of steel, giving physical data, electrical properties, heat resistance, working and treating temperatures, etc. Other tables list corrosion resistance to various media. Other chapters discuss various types of stainless in more detail, also heat resistant and low temperature properties. Book is available to qualified power engineers, please state title. Allegheny Ludlum Steel Corp.

140 Steel Stock List — Providing information on company's steels for immediate shipment, this 140-pp booklet also covers engineering services available, trade customs, cutting and shearing charges, and is thumb-indexed and compiled for easy ordering. Plates, sheets, beams, channels, bars, strips, boiler tubes, heavy hardware and other forms are included along with sizes, weights, prices. A section of useful engineering data includes tables of constants, steel color chart, AISI and SAE specifications. W. J. Holliday & Co., Inc.

141 Die Pressed Forgings — Publication B-9 is a recently revised edition of company's handy reference booklet on copper and copper-alloy die pressed forgings. This 12-pp booklet provides practical comparative illustrations to show what die pressed forgings are, what they can do, what they already have done and what can be expected of them. Contains tabulation of physical properties of copper and copper alloys suitable for forgings. The American Brass Co.

142 Copper Clad Metal — Form E100 gives the properties, applications and advantages of a copper clad metal formed with base metal of low carbon magnetic steel metallurgically bonded with rolled copper. Stresses strength of this copper-saving metal, its lighter weight, improved electromagnetic shielding action. American Cladmetals Co.

143 Creep Stress of Tubing Steels — Technical information of value in selection and use of equipment operating at high temperatures and pressure is given in Data Card 102 which provides creep stress figures for a number of tubing steels. Data given for rates of 1 per cent elongation in 10,000 and 100,000 hr at temperatures from 800 to 1500 F for 16 popular carbon, intermediate alloy and stainless steels. The Babcock & Wilcox Tube Co.

SAFETY

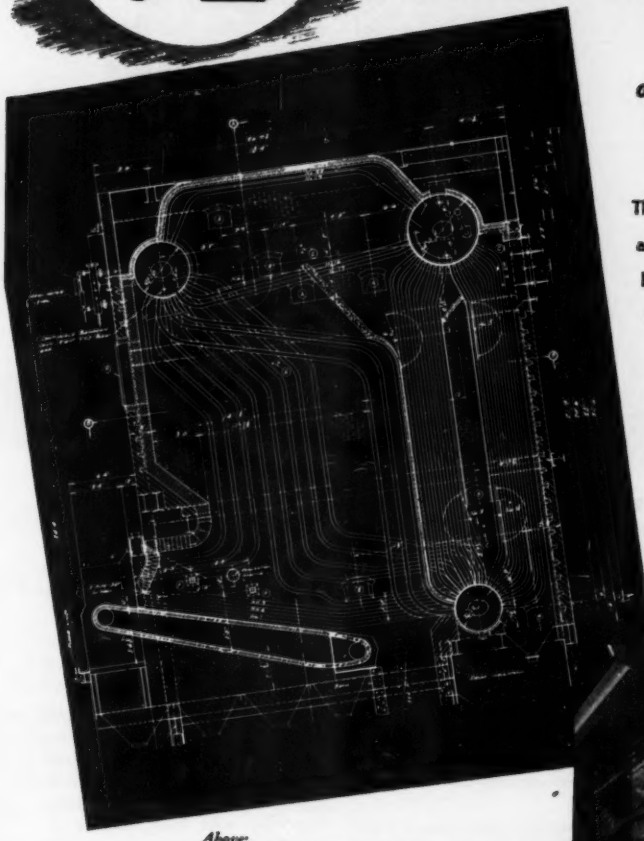
144 Electrical Properties of Rope — This 8-pp booklet stresses safety advantages of manufacturer's manila rope specially treated and processed to make it more shock resistant and safer for use around high tension lines etc. Presents electrical properties of this rope, of manila rope waterproofed by other methods and of non-waterproofed rope. South Eastern Cordage.

CLASS **VL**

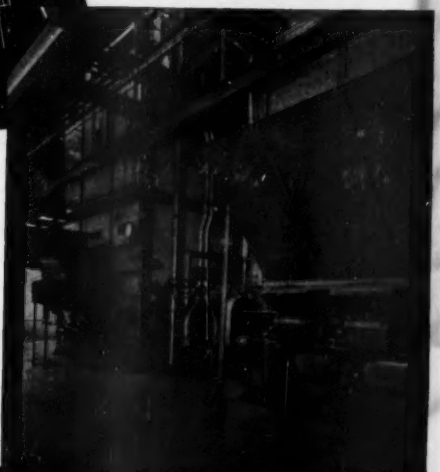
Vogt Steam Generating Units

for POWER *or* PROCESSING LOADS, *and* HEATING

The design provides large furnace volume and a high ratio of radiant heating surface. Proper combustion is assured with any fuel or method of firing. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Vogt Class VL Steam generating units are giving satisfactory service in Hotels, Sugar Refineries, Steel Mills, Furniture Factories, Distilleries, Oil Refineries, and related industries. A bulletin showing typical installations will be sent upon request.



Above: This 90,000 lbs. steam per hour unit, designed for 475 lbs. pressure, serves the Mansfield Tire & Rubber Co., Mansfield, Ohio.



Right: Two 515 H.P. units installed in Brown-Forman Distillers Corporation, Louisville, Ky. Plant.

HENRY VOGT MACHINE CO. • 1000 W. Ormsby St., Louisville 10, Ky.
Branch Offices: New York, Philadelphia, Cleveland, Chicago, St. Louis, Dallas

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BELMONT 189... for cold and hot oil rods and plungers.
BELMONT 19... for hot and cold water rods and plungers, low and intermediate steam rods.
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BELMONT Packings, unlike "run of the mill" packings, are the remarkable, trouble free, product of packing specialists who have devoted more than half a century to the problem of producing packings with a *Better Seal* and *Longer Life*.

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145 Easy Breathing Respirator — Illustrated Bulletin CR-26 provides 2 pp of information on a new compact respirator with improved filter and offering much less breathing resistance than previous models with same dust collecting efficiency. Includes details of construction. Mine Safety Appliances Co.

ENGINE ACCESSORIES

146 Engine Starting Motors — Two new air cranking motors for starting service on diesel and gasoline engines with piston replacements to more than 3500 cu in. are introduced in 8-pp illustrated Form 5094. Data provided includes specifications, dimensions, recommended throttle and lubrication arrangements and an air cranking motor selection list covering 15 leading makes of engines. Ingersoll-Rand Co.

147 Governor Efficiency Explained — "How to Get the Most Out of Your Governor" is a 12-pp up-to-date presentation of centrifugal governor problems and applications. Illustrated with photos, schematic drawings and charts, describes operation of governing mechanisms and explains governor weight energies and calibrations. Includes discussions on valve boxes, shafts and linkages; positioning of governor levers and geometry of connections; causes and effects of engine condition on governor efficiency. Details on adjustment, maintenance included. The Pierce Governor Co., Inc.

OTHER EQUIPMENT

148 Single-Tank Deionizer — Bulletin 512, 6 pp, describes single-tank deionizers of mixed-bed, monoflo design which provides greater capacity and produces water of high chemical purity free from ionizable impurities including CO_2 and silica. Illustrated, includes engineering and technical data. Elgin Softener Corp.

149 Which Refractory? — Form 5120, titled, "Super Refractories," is a 12-pp illustrated booklet explaining characteristics of several quality refractories and telling the job each is best suited for. Not an ordering book, covers silicon carbide, electric furnace mullites, electrically fused alumina refractories and fused cast refractories, discussing them from standpoints of heat resistance, heat conductivity, chemical inertness, resistance to abrasion, spalling and thermal shock. Pictures available shapes, includes table of physical properties. The Carborundum Co.

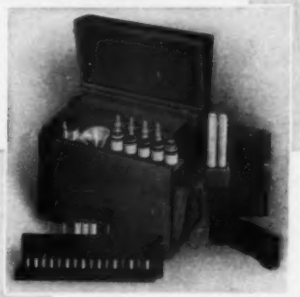
150 Improved Concentrator — Illustrated Bulletin 118, 2 pp, presents Series 6600 of company's improved No-Frost concentrator, offering 15 to 36 gph capacities and designed to handle large live loads quickly. Pictures six installations. Niagara Blower Co.

151 Directory of Rubber Parts — This 12-pp catalog describes company's manufacturing facilities including a new rubber compounding mill and products and services offered. Illustrated with photos, covers sheet rubber lined tanks and formdipped rubber parts, molded and extruded products. Automotive Rubber Co., Inc.

152 Heating Equipment and Systems — Sixty-pp Catalog G-99 presents not only up-to-date ordering information on company's heaters and hot water heating specialties, but also design tables and engineering data for venturi systems, two-pipe reverse return systems, panel heating systems, snow melting systems. Also contains parts list and section on servicing of circulators, valves, flow checks, and a double-page check chart providing basic remedies for common hot water heating and indirect water heater complaints. Taco Heaters, Inc.

153 Welding Accessories — Bulletin 101 on arc welding accessories, illustrates and describes features and advantages

Only Taylor Comparators give PERMANENTLY GUARANTEED COLOR STANDARDS for Testing pH, Phosphate



Simply place reagent treated sample in middle tube in base, move the color standard slide until colors match and . . .

There's the Value!

There's no danger of mechanical inaccuracy when you use a Taylor Comparator for determining pH or phosphate in boiler water . . . because *all Taylor liquid color standards carry an unlimited guarantee against fading.*

One sturdy plastic slide houses all color standards necessary for any one determination. Each Boiler Water Set is packed in light-weight, convenient carrying case with base, slides, reagents and accessories. The utility of these sets is high, but their cost is low!

SEE YOUR DEALER FOR TAYLOR SETS

Also ask about the new Taylor Water Hardness Set that eliminates the time-consuming soap tests.

Write direct for your free copy of "Modern pH and Chlorine Control" if this valuable reference is not already in your library. Gives theory and practice of modern boiler water testing, describes and illustrates Taylor equipment.

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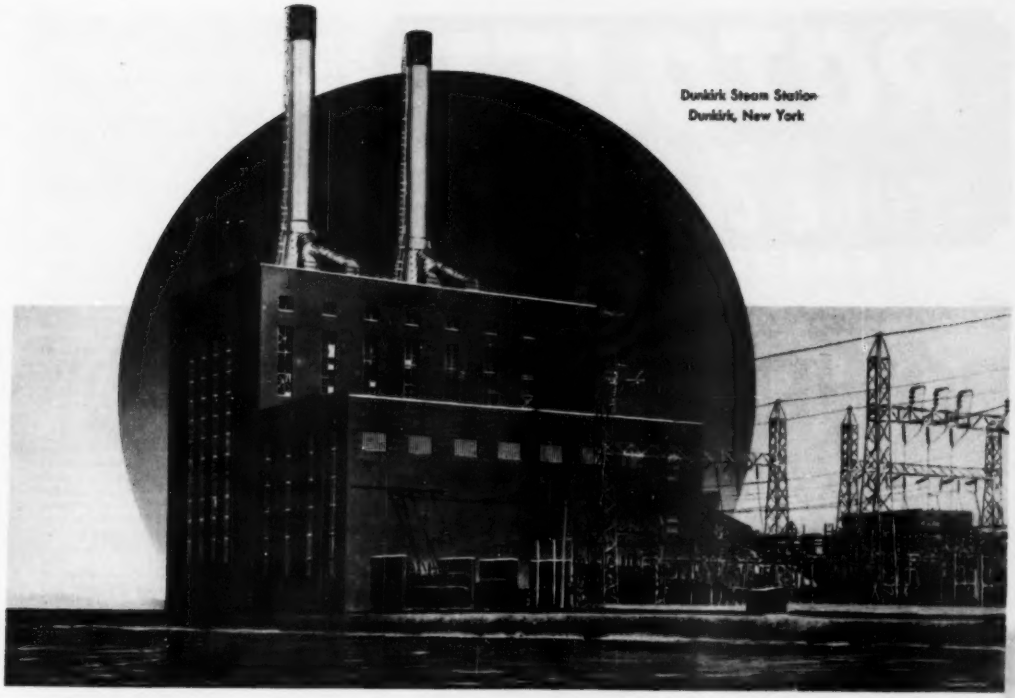
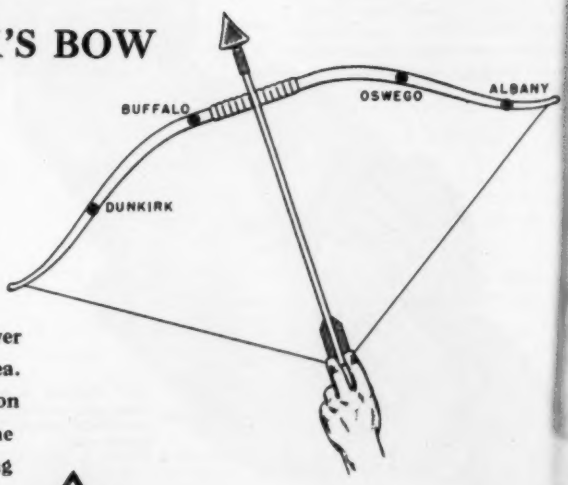


Dunkirk Steam Station
Dunkirk, New York

MORE POWER FOR NIAGARA MOHAWK'S BOW



The new Dunkirk Steam Station adds 160,000 kw of thermal generating capacity to the western end of the Niagara Mohawk Power Corporation system. This is an important step in the expansion program planned to satisfy the rapidly increasing industrial power demand in the Upper New York State area. Stone & Webster Engineering Corporation was the supervisor of construction of the station which was designed by the engineering staff of Niagara Mohawk.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY of STONE & WEBSTER, INC.

ROTOJET
Water-driven
TUBE CLEANERS

Deliver all the
POWER
you need for
QUICK RESULTS

ROTOJET ® Water-driven Tube Cleaners provide power heretofore obtainable only with air-driven equipment. A vast increase in power and a material reduction in water consumption were achieved through radical design changes based upon latest research in hydrodynamics.

The new ROTOJET removes the hardest scale much more quickly and efficiently than ever before possible with water-driven equipment. Send for new ROTOJET Bulletin.

C321 ROTOJET Water-driven Motor with short 4-arm head and universal joint for 2¼" I.D. straight tubes.

ELLIOTT COMPANY-ROTO DIVISION
147 Sussex Avenue Newark 1, N. J.

of company's cable connectors, electrode holders and terminal connections. Cam-Lok Div., Empire Products, Inc.

154 How Summary Cards Can Help — Featuring a two-in-one machine for producing punched card reports and summary cards, this 6-pp bulletin tells how summary cards can speed reports, serve as a basis for additional accounting applications, reduce clerical help etc. Illustrates a detail card, weekly listings of gross pay summary cards, labor distribution cards. Remington Rand Inc.

CATALOG LIBRARY

(Continued from page 54)

in 12-pp Bulletin DB-4673 on high-voltage combination starters. Because almost every 2300/4800 v power system can produce high currents under short-circuit conditions, booklet stresses this interlinked protection, covering three classes of combination motor starters: an air-break type for squirrel-cage induction motors; a starter with oil-immersed contactor, and a combination synchronous motor starter. Westinghouse Electric Corp.

VALVES, TRAPS, PIPING

235 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates design and construction of company's quick-operating valves, explaining their application to blow-off service and on chemical process, soot blower, water column blow-down, and other types of pipe line. Includes dimensions, weights; prices. Everlasting Valve Co.

236 Popular Steel Valves — Condensed Catalog 104, 28 pp, describes and illustrates most widely used of company's cast and forged steel valves and the data presented for these valves is complete. Those listed are chiefly in the basic steam pressure classes — 150 to 2500 lb — and include globe and angle, gage, instrument, hydraulic and relief types, also strainers, and check, gate, non-return and blow-off valves. Explains design features. Edward Valves, Inc.

237 Valves, Fittings and Flanges — Catalog F-9 is a 400-pp, permanently bound reference book on drop forged steel valves, fittings and flanges for practically all piping needs at high and low pressures and temperatures. Provides ordering information on company's complete line, also much helpful engineering and application data; includes a section on products for refrigeration service. Fully illustrated, indexed. Available to qualified power engineers, please give your title. Henry Vogt Machine Co.

238 Valve Specialties — Included in 90-pp Catalog A-50 is complete ordering and engineering information on automatic pressure flow and liquid level controls for steam, air, gas, water, oil, other fluids. Sections are devoted to pressure regulators, altitude valve, pump governors and strainers; lever, float and motor operated valves, pilot valves; back pressure, relief and non-return valves, steam trap and air vent; liquid level controllers; solenoid valves. Includes capacity charts. Davis Regulator Co.

239 Pressure Reducing Valves — Selection and engineering data on pressure reducing valves, including those for remote control of reduced steam or water pressures, are presented in 12-pp Bulletin 477-A. Northern Equipment Co.

240 Safety Valve Engineering Data — How company's safety valve works and its operating advantages are explained in Bulletin 707. Includes dimensions on valve types, tables on superheat correction factor. Manning, Maxwell & Moore, Inc.

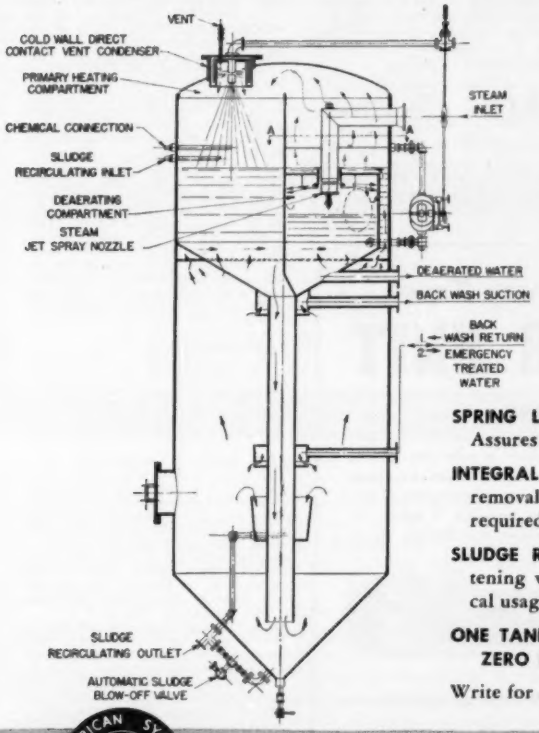
241 High Pressure Gate Valve — Described in 4-pp Form DH-273 is a forged steel gate valve designed for long service and low cost maintenance. Working pressures, sizes and prices listed. R-P & C Valve Div., American Chain & Cable Co., Inc.

242 Forged Steel Valves — Form 800-A describes 600-lb forged steel valves for high line pressure and temperature applications. Covers both inside screw and OS&Y

AMERICAN'S ANSWER TO...

America's POWER ENGINEERS

DEAERATING HOT PROCESS SOFTENER



POWER ENGINEERS will recognize in this American multi-purpose system, one answer to many water conditioning problems.

This Deaerating Hot Process Softener insures a safe, uniform boiler feed that is soft, clear, hot, free of oxygen and CO_2 with silica content reduced to a minimum.

Compare this system, feature for feature. Find out why American engineering skill and fabricating "know how" is answering America's Power Engineers with results, performance and economy.

COLD WALL DIRECT CONTACT VENT CONDENSER . . . Prevents scaling.

SPRING LOADED STEAM JET SPRAY NOZZLE . . . Assures maximum efficiency at all loads.

INTEGRAL "ATOMIZING TYPE" DEAERATOR . . . For removal of oxygen and CO_2—no booster pump required.

SLUDGE RECIRCULATION . . . Insures maximum softening with turbidity removal at minimum chemical usage.

ONE TANK
ZERO DEAERATION

ZERO HARDNESS
UNIFORM RESULT

Write for complete details.

AMERICAN SYSTEM AWS PATENTED

The **AMERICAN WATER SOFTENER COMPANY**

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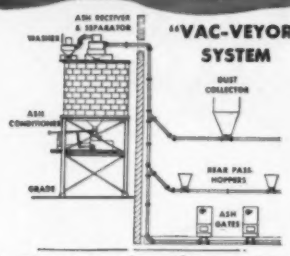
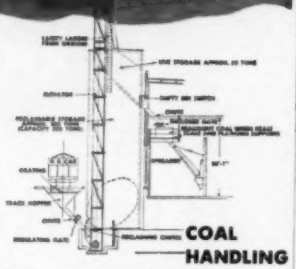
FILTERS • SOFTENING SYSTEMS • CHEMICAL FEEDERS • ION EXCHANGERS • RE-ACTORS • SWIMMING POOL EQUIPMENT • DE-GASIFIERS • WATER TEST SETS • RE-CARBONATORS • ALKALIZERS

Profits Saved AT EVERY STAGE ... WITH BEAUMONT COAL & ASH HANDLING EQUIPMENT



"VAC-VEYOR" SYSTEM

In this system, ashes, siftings, soot and dust are conveyed by pipe from the ash pits, dust collectors, stack, etc., to an ash receiver and separator at the top side of a silo—by means of a vacuum. One man operates the system, keeping your plant cleaner with less labor. Send for Catalog.



COAL HANDLING

Coal arrives by rail, is dumped into hopper, raised by bucket elevator and discharged either into bunker for immediate use or down chute to yard storage. One operator controls all equipment. Send for Catalog.

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Designers Manufacturers Erectors BULK MATERIAL HANDLING SYSTEM

Nicholson Expansion Steam Traps

SAVE $155 PER UNIT

for Large Processor

Because of their positive effectiveness in temperature control work, Nicholson expansion steam traps, at about $35 each, are being installed by a leading processor in place of temperature controls. These were costing them $110.00 to $200.00, with cost of a trap added. Per installation, the saving is about $155.00.

Because there is only one moving part, remarkably low maintenance costs are being shown. Easily installed, usually without supports. Lengths, 9" to 40". Pressures, 0 to 250 lbs. No air binding.

This firm is finding an increasing number of applications on tanks, stills, heating radiators, etc., where Nicholson expansion steam traps are serving as both trap and temperature controller.

For All Equipment Using Steam or Hot Water

Radiators
Separators
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Pipe Coils
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Railway Coaches
Dry Kilns
Vulcanizers
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Plastic Molding Presses

Catalog 751 or see Sweet's

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union bonnet gate types, giving sizes, prices. Chart shows trim metals for different services. The Ohio Injector Co.

243 To Get at those Valves — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels. Babbitt Steam Specialty Co.

244 Steam, Air and Gasoline Traps — Catalog 751, 32 pp, is a 32-pp ordering book on traps. It's fully illustrated, provides capacity tables, installation diagrams and a section containing data, charts and formulas for determining proper size trap for specific applications. Covers thermostatic steam traps for pressures to 225 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air, gasoline, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lb. W. H. Nicholson & Co.

245 Trap Data — Here's a 12-pp condensed catalog giving information and prices on steam and air traps. Lists cast semi-steel and forged steel inverted bucket traps, compound steam traps, ball float air traps, Y-type strainers and internal check valves. Provides data on calculation of condensate loads and a selection of traps to handle these loads, also a full-page capacity chart. A parts list is included. Armstrong Machine Works.

246 Steam Trap Reference Manual — Bulletin T-1740, 24 pp, tells why and where steam traps should be used; explains desirable trap features. Advantages of company's impulse steam traps are described, their operation illustrated. How to figure traps sizes and how to size condensate return lines are told and capacity and pipe dimension charts and thermodynamic properties of saturated steam included. Also provided are installation and operating suggestions, prices. Yarnall-Waring Co.

247 Steam Traps and Temperature Controls — Here is a comprehensive catalog comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap selection chart. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Sarco Co., Inc.

248 Strainers and Separators — Bulletin R-46-50A is a 16-pp catalog on T-type strainers, suction strainers, multiflow and receiver separators. Contains dimensions, weights, prices. Shows how several types have been redesigned for increased efficiency. American District Steam Co.

249 Safety Head Catalog — Section 10, Part 1 of Catalog 54, 52 pp, is written in non-technical language and fully illustrated with cutaways and installation photos, charts and tables covering almost any phase of safety head information desirable. Tells where safety heads can be used and how to use them. Tells how to choose safety head assemblies and rupture discs. Includes tips for lowering temperature at point of safety head location. Black, Sivalls & Bryson, Inc.

250 Design Properties of Pipe — This 12-pp booklet consists of tables listing pipe sizes and wall thicknesses currently established as standard, plus what is believed to be a most complete tabulation of dimensional properties of commercially available sizes of steel pipe. Tube Turns, Inc.

251 Piping Pointers — This is company's highly popular 36-pp manual covering fundamentals of sound piping practices. Discusses various types of valve designs and how each should be used. Pictures and names more than 80 fittings and contains illustrated how-to-do-it features. Includes 8 pp valve selection guide. Crane Co.

252 Handbook on Fittings and Flanges Catalog wf-1950, 88 pp, gives working information on seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules

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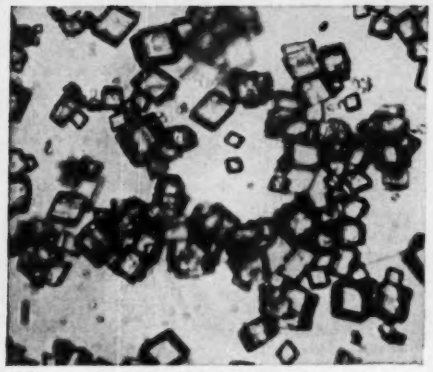
No. 26 Series

ORGANIC SLUDGE DISPERSIVE

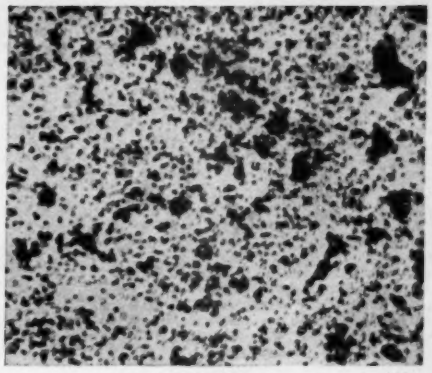
Controls Sludge-Scale



500X

UNTREATED

Note large crystal size



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Inhibited crystal growth and dispersion keep sludge fluid

BOILER SLUDGE CAN FORM SCALE . . . because of its inherent tendency for adhering to heat transfer surfaces.

The dispersive property of Allis-Chalmers No. 26 Treatment prevents crystal growth and produces a fluid sludge, readily removed by blowdown.

To you, the engineer, this means cleaner boilers — boilers that seldom if ever require turbining or other forms of cleaning. No. 26 Treatment does not soften the water, but it can be mixed with softening chemicals (if desired) without reducing its effectiveness as a sludge conditioner. This simplifies its application and reduces your investment in feeding devices.

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1/10 part per 1,000,000

. . . in condensate and process waters

Are you discarding oil-contaminated water . . . or re-using it without adequate purification? If so, you may find filtration with Sorbo-Cel a relatively simple, inexpensive solution to your problem.

Easy, low-cost clarification . . .

Sorbo-Cel is a specially processed diatomite powder. Used in conjunction with any standard screen-type filter unit, it provides a fast, easy and inexpensive way to absorb emulsified oil and other impurities from water. Total processing costs (including both material and operation) are only from 1¢ to 3¢ *per 1000 gallons.*

How Sorbo-Cel works . . .

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Other important advantages . . .

In addition to trapping out oil globules, Sorbo-Cel filtration removes suspended solids such as rust, scale, and clay. Boiler-tube life is increased, scale formation is reduced, and shutdowns are less frequent. In plants using graphite or wet-steam lubrication to keep condensate oil-free, this method permits a return to the more efficient oil lubrication—with resultant economies in ring wear.

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PE-4

with specifications, list prices and sizes, book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings. Grinnell Co., Inc.

253 Unions and Fittings — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. E. M. Dart Mfg. Co.

254 Flanges for Severe Service — This 4-pp bulletin describes a flange specially developed for services involving severe abrasion and corrosives, and for suction and discharge service. Goodall Rubber Co.

FUEL OILS, LUBRICANTS

255 Fuel Oil Treatment — By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and correction of these conditions by company's treatment. E. F. Drew & Co., Inc.

256 Air Compressor Lubrication Manual — Valuable information on air compressor maintenance is contained in this 40-pp book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, safety precautions. Cities Service Oil Co.

257 Diesels, Their Fuels and Lubricants — This 46-pp book gives practical information on diesel engines, covering their history and economics as well as design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, also lubricating systems, and diesel oil purification and filtration. Includes discussion of fuel and lubricating. Sinclair Refining Co.

258 Viscosity of Fluids — The larger significance of viscosity is discussed in Nos. 5 and 6, Vol. 36 of Lubrication, a technical publication. In six parts, the first illustrates simplest conception of streamline flow between two surfaces having relative motion. A series of torsion viscometers shows how viscosity acts and may be measured. Part II covers streamline flow in capillary and other small tubes. Part III covers turbulent flow in pipes. Part IV discusses effects of temperature and pressure on viscosity, and Part V includes viscosity index. Part VI gives brief reference to nature of plastic flow. The Texas Co.

INSTRUMENTS AND CONTROLS

259 For Centralized Control — Bulletin 109 presents compact Mini-Line equipment suited to control board arrangement which concentrates vital operating information and controls for one or more boilers, turbines or process units before a single operator. Describes and illustrates vertical-scale indicator units, selector valve, remote manual relay. Bailey Meter Co.

260 Remote Reading Flow Meters — Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described. Republic Flow Meters Co.

261 Flow Meters — Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1½ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, bulletin discusses meter's advantages. Builders-Providence, Inc.

262 Putting the Ratio Totalizer to Work — Twelve applications of company's ratio totalizer in automatic control

Up-to-the-minute CO_2 READINGS

with the RANAREX INDICATOR AND RECORDER can save 10%

OR MORE OF YOUR FUEL DOLLARS

For a quick, dependable check on CO_2 content of flue gases, use RANAREX! It's a sure check that is accurate to within 3/10 of 1% of CO_2. Ranarex uses no chemicals, is sturdily constructed and easily maintained.

Get the *free* Ranarex booklet by writing to The Permutit Company, Dept. PE-10, 330 West 42nd Street, New York 18, N. Y., or to the Permutit Company of Canada, Ltd., Montreal.

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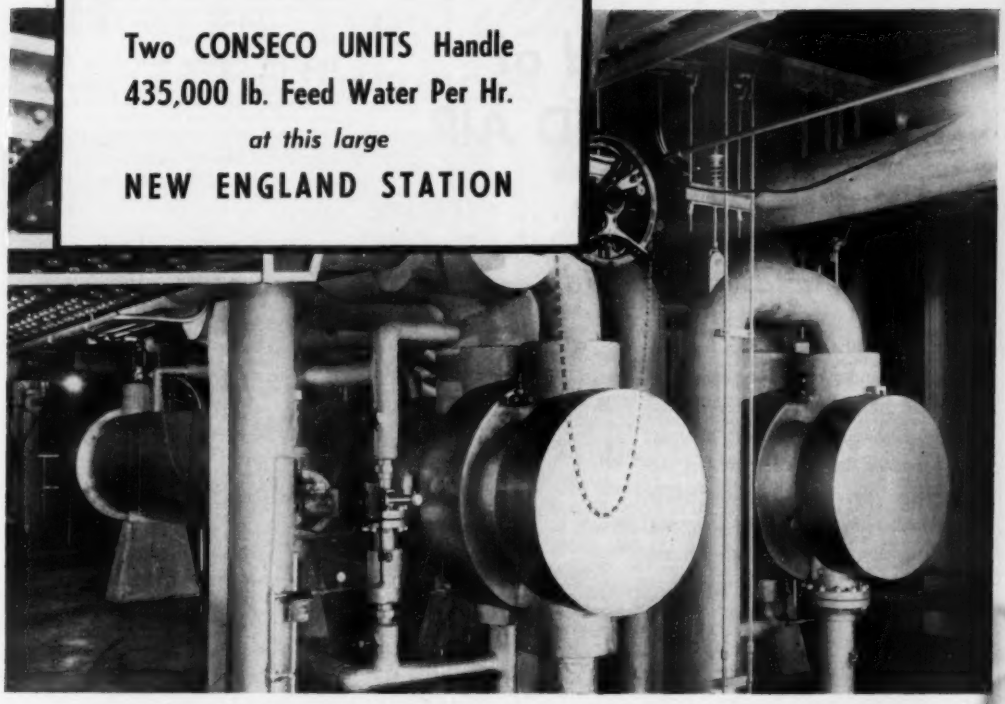
PRODUCT OF PERMUTIT

Two CONSECO UNITS Handle
435,000 lb. Feed Water Per Hr.
at this large
NEW ENGLAND STATION



It Will Pay You to Look into These FW Heater Advantages . . .

The two Conseco Feed Water Heaters shown are installed in the central station of a large New England public utility company. Each unit is a low pressure, internal floating head, removable bundle type.

The larger of the two units has 3,000 sq. ft. of surface, uses extraction steam and handles 380,000 lb. of water per hour. The smaller, 2,500 sq. ft. unit, is fitted with an integral drain cooler and handles 435,000 lb. of water per hour, using extraction steam. Liquid level in the drain cooler section is automatically controlled.

May we suggest that you consult Conseco Engineers about your particular feed water heater needs? They will be glad to tell you about the many advanced heater features which assure trouble free, low cost performance in your plant.

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PRODUCTS INCLUDE

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EVAPORATORS
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DEAERATORS
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REFINER FILTERS
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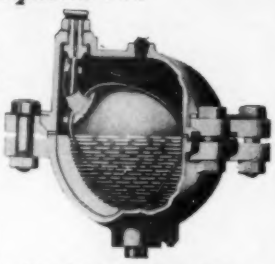
STEAM JET AIR EJECTORS

Condenser SERVICE & ENGINEERING COMPANY HOBOKEN, N. J.

WRITE TODAY for latest engineering bulletins on Conseco Feed Water Heaters and other power plant equipment.

How to get rid of ACCUMULATED AIR IN PIPE LINES . . . *carrying hot or cold water, industrial liquors, sewage and other liquids . . .*

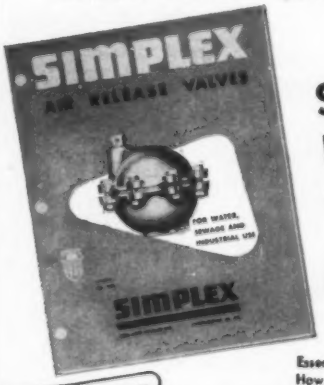
The accumulation of air in water lines under pressure presents the engineer with many problems. Air, lodging at peaks in the line, reduces the effective area of the pipe, creates a friction head, lowers the entire line's pumping capacity, and may result in serious water hammer.



Simplex Air Release Valve

The Simplex Air Valve is easily installed . . . positive in action . . . ample in capacity. Standard valves for pressures up to 250 p.s.i. . . . special valves for pressures up to 800 p.s.i. Thousands have been in successful use for over 30 years.

Simplex Air Release Valves bring a sure, efficient cure for these difficulties. Easy to install, simple in design, positive in operation . . . they vent accumulated air automatically before it can cause damage. To learn how *you* can avoid accumulated-air troubles, send without obligation for our new bulletin.



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PARTIAL CONTENTS

Essential Requirements for Air Release Valves
How Simplex Takes Care of Air in Pipes
Methods of Installation
Design and Construction Details

Write to Simplex Valve & Meter Co., Dept. 10, 6753 Upland St., Phil. 42, Pa.

IT'S ACCURATE IT'S SIMPLEX

SIMPLEX
VALVE AND METER COMPANY

circuits are shown in 8-pp Bulletin 5450. This is a pneumatically operated control mechanism for combining input control pressures and spring forces to produce a single output control pressure. Hagan Corp.

263 For Practical Men — This 24-pp pocket-size booklet presents insulation testing in simple language. Packed with maintenance hints, explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in long run economy. James G. Biddle Co.

264 Air Locks — Illustrated Bulletin S-31, 2 pp, describes company's air locks and trip master controls for holding regulating and control valves in position during failure of air supply. The Swartwout Co.

265 Flow Tubes — Catalog 80, 4 pp, presents engineering data on a primary element for measuring, regulating, controlling fluid flow. Tells how flow tubes are designed, function. Foster Engineering Co.

266 Control Equipment — General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Describes in detail: venturi tubes and meters, controllers, gages, manometers, pilots. Simplex Valve and Meter Co.

267 Steam Calorimeter — Bulletin 118 discusses an improved U-path calorimeter combining a throttling, separating and re-evaporating calorimeter in a single chamber. Explains and illustrates construction and operation of the unit and quotes letters from users of this type of equipment. Ellison Draft Gage Co., Inc.

268 Metered Liquid Handling — Bulletin OG 400 contains 12 pp of selection and ordering data on positive displacement type meters. Explains and illustrates operation, giving specifications, dimensions. Also presents several types of registers, register extensions, strainers and remote registration unit. Includes table of material recommendations for meter parts for use with 200 different liquids. Rockwell Mfg. Co.

269 Pressure Regulator — Bulletin 1-B, 8 pp, discusses design, operation and applications of a super-sensitive pressure regulator; shows typical installations. Also covers a compound regulator for controlling back pressure relief valve and high pressure make-up valve. Atlas Valve Co.

PACKINGS

270 Pump Packings — Packings for reciprocating and centrifugal pumps are described in this folder. Covers packings for practically all services. Johns-Manville.

271 Teflon Packings — Form AD143 offers 8 pp of information on Teflon packings and gasketing material, giving properties, typical and special applications. Includes chapter on toxicology of Teflon at extremely high temperatures. The Garlock Packing Co.

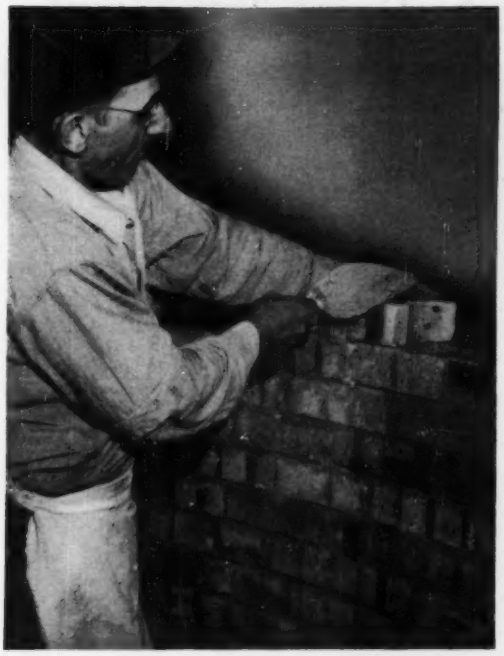
272 Manual on Packings — Containing 84 pp of engineering and ordering information, Catalog 40 covers packings for practically every service. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

273 Packings and Gaskets — Catalog P-100C, 32 pp, covers 95 most popular packings and gaskets in company's line, furnishing details of construction, service recommendations and size information. Includes charts showing specific recommendations for a wide variety of applications. Packing Div., Raybestos-Manhattan, Inc.

274 Long Wearing Piston Packing — Form 4502, 8 pp, stresses use of company's composition cups for packing the pistons of air and hydraulic cylinders and reciprocating pumps. Engineering information covers properties, textures available, temperature, pressure data. Darling Valve & Mfg. Co.

(Continued on page 145)

How to Avoid *JOINT TROUBLE* In Furnaces or Kilns



Norton RA1019 Alundum* cement is recommended for laying up either silicon carbide or fused alumina bricks and blocks. It assures strong, thin refractory joints.

If your furnace or kiln walls weaken at the joints first, there are several possible causes. The cement may not be refractory enough and shrink excessively. It may be too coarse. The joint may be too thick.

What's the solution? Many users of refractory shapes have found that Norton RA1019 Alundum cement used in conjunction with Norton Crystolon* or Alundum brick make a combination that adds extra life to furnace and kiln walls.

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

RA1019 ALUNDUM CEMENT

For most installations, users agree, you can't go wrong with Norton RA1019 Alundum cement for laying up either silicon carbide or fused alumina brick. This fine-grained, chemically stable cement, containing 80% fused alumina, matures at 1850°F and withstands temperatures up to 3100°F.

Here's how to use it. Dry-mix it before you add water to redistribute the bond and fines that may have settled out during shipment or storage. Then add enough water to make a slip just heavy enough to be troweled. Remember to stir it a bit every time you dip your trowel into it. Tap each brick into place . . . and you'll get thin, smooth joints that can really take it.

In cases, however, where a silicon carbide cement is mandatory — as in zinc and zinc oxide furnaces — Norton RC1130 Crystolon cement has proved eminently satisfactory.

CRYSTOLON BRICK

For lining forge furnaces and as piers and supports in oil- and gas-fired furnaces — where the use of fire clay is impracticable — Norton Crystolon refractory brick have piled up handsome performance records. It's not surprising. These silicon carbide brick are highly refractory (decompose at 4082° F) and highly resistant to thermal shock. They show no deformation under loads of 50 psi at 1500°C and no shrinkage at temperatures up to 2732° F. Their smooth surfaces lend themselves admirably to thin, smooth joints.

ALUNDUM BRICK

Where resistance to oxidation and basic slags is the determining factor in your choice of refractory, Norton Alundum brick are recommended over silicon carbide. Made of chemically stable fused alumina in percentages ranging from 92.0 to 99.5 depending on the grade, Norton Alundum brick are highly refractory, usable at temperatures up to 3350° F.

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GET ALL THE FACTS

Two new Norton Bulletins — packed with factual data on refractory cement and brick selection — are yours for the asking. Contact your nearby Norton representative or write for Bulletins 863 and 862.

NORTON COMPANY
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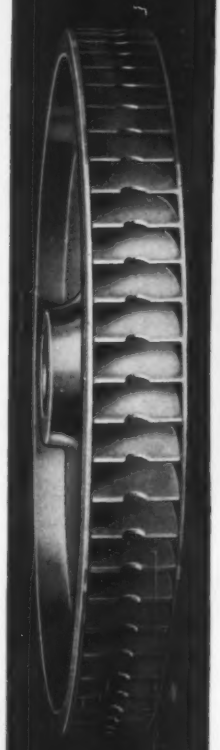
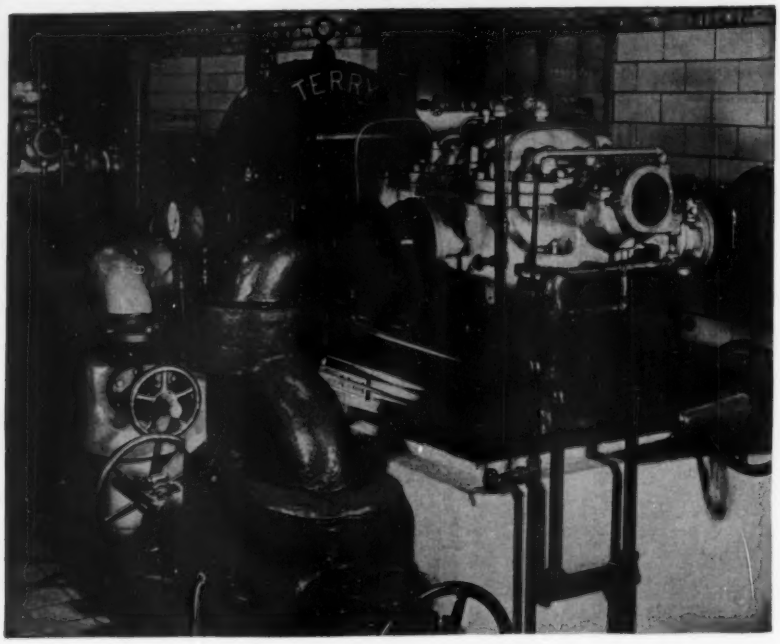
Worcester 6, Mass.

TERRY





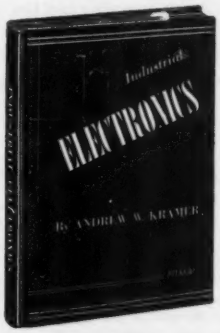
110hp Feed Pump Turbine with Large Safe Clearances

The blades of this turbine are milled out of a one-piece forged-steel wheel with generous clearance both radially and axially. The side clearance is very large — one inch — and the blades are protected by a projecting rim on each side of the wheel. It is therefore impossible for the blades to foul and end play can do no damage to the turbine.

These are but a few of the features that make the Terry Solid-Wheel Turbine such a dependable driver. A bulletin giving other interesting facts about this turbine will be sent upon request.

T 1179

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



a practical new book about Electron Tubes

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. . . how they work
. . . how they can be used
. . . what they can mean to you

INDUSTRIAL ELECTRONICS

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This new book explains in clear, simple, non-technical style the basic principles of electronics, and how these principles can be applied in industry. Electronics has been solving the unsolved problems. Whether it is navy beans, opening doors at a shadow, or measuring the thickness of red-hot steel plates, the electron is the newest and most efficient force captured by science. This book should be invaluable for the practical maintenance or operating executive or engineer. 311 pages, 229 illustrations, $6.00.

CHAPTER HEADINGS: Electron Behavior, Fundamental Principles of Electron Tube. The Simplest Thermionic Tube—the Diode. The Triode. Further Aspects of Triode Characteristics and Operation. Electronic Generation of Electric Oscillations. Multielement Tubes. Effect of Gas in a Tube. Types of Characteristics of Gas-filled Tubes. Mercury-pool Tubes. Photoelectric Tubes and Cells. Cold-cathode Tubes. Special-purpose Tubes. What Tubes Can Do. Electronic Control and Regulation. Application of Electron-tube Rectifiers. Electronics in Instrumentation and Measurement. Industrial Applications of Electronic Control. Application of Electronic Regulation. Electron Tubes in Light Production. Miscellaneous Electronic Applications.

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Before

A view of boiler room of large Eastern industrial plant before underfeed stokers were replaced with National Airoil Oil Burners.

After

After installation of NATIONAL AIROIL TYPE S.A. Oil Burners under the four boilers pictured above. Note that lower front walls of the three right hand boilers have been extended. Also note angle fronts to permit firing at high ratings without impingement of flame on side walls. Either forced or natural draft may be used. Total capacity 2800 HP. Large savings were made on stoker and ash handling equipment repairs; brickwork maintenance. One operator now easily cares for all four boilers.

For 39 years—continuously since 1912—NATIONAL AIROIL BURNER COMPANY has devoted its entire efforts to the design, development, manufacture and application of successful Oil and Gas Burning Equipment. The same equipment is used throughout the U. S. and foreign countries.—Many models in varied sizes are available to cover a wide scope of applications and special problems.—Send us details of *your* plant; our engineering department will gladly offer recommendations.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

NATIONAL AIROIL BURNER COMPANY, INC.

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NEWS *from* THE FIELD

G. E. APPOINTMENTS

ALAN HOWARD has been appointed operation manager for the Gas Turbine Division of the General Electric Company's Turbine Divisions, according to an announcement by G. B. Warren, divisions manager.

In his new post, Mr. Howard will have the responsibility for commercial, engineering, manufacturing and accounting functions in the Gas Turbine Division.

Subsequently, Mr. Howard announced the appointment of J. P. Keller as assistant operation manager of the division.

J. P. Keller joined General Electric in 1929 as a student on the Apprentice Training Course. In 1935 he entered Iowa State College and was graduated in 1939 with a B.S. degree in mechanical engineering.

* * *

RILEY STOKER CORP. announces the establishment of a direct factory branch office at 504 Pan American Bldg., Camp and Poydras Streets, New Orleans, La. This office will be in charge of T. C. Beatty, District Manager.

* * *

WARREN STEAM PUMP CO., Inc., Warren, Mass., announce that they are now represented in up-state New York through a recently opened office of their Pittsburgh representatives, Process Industries Engineers, Inc., Pittsburgh, Pa., who have recently opened an office in 703 Temple Bldg., Rochester 4, N. Y. J. L. Woll is in charge.

* * *

W. H. HILL, President of Baldwin-Hill Co., Trenton, New Jersey, has just announced the purchase of the Tex-Rock Insulation Manufacturing Co.

* * *

CLAYTON S. COGGESHALL has been appointed assistant to the manager and Robert S. Neblett has been named manager of sales for the General Electric Turbine Divisions according to an announcement by Glenn B. Warren, manager of the divisions.

* * *

MANNING, MAXWELL AND MOORE, INC., are celebrating their one hundredth year in business in 1951, have rented a large portion of the eleventh floor of the new 32-story Chrysler Building East, in New York City.

* * *

HAVING MOVED executive, engineering and sales offices to Tucson, Arizona last September, Infilco Incorporated has started construction of a new headquarters building. The new building, for which contracts were recently let, will occupy 7½ acres, comprise 36,000 square feet floor space, house over 200 employees and cost more than $400,000. When the new building is completed, the chemical laboratories will be brought out from Chicago to join the other divisions and will occupy their own specially designed laboratory. Manufacturing and certain phases of engineering will remain in the Chicago Plant at 325 West 25th Place.

* * *

F. S. KOHL has been appointed operation manager of General Electric's Fitchburg Turbine Division according to an announcement by G. B. Warren, divisions manager.

WILLIAM E. SAUPE has been appointed operation manager, and Will Pruessman has been named manager of manufacturing of the Schenectady Steam Turbine and Generator Divisions.

* * *

ROBERT D. BAIRD, who in 1949 was awarded an Allis-Chalmers graduate fellowship for 12 months' resident study at the University of Wisconsin, received his doctor's degree in mechanics from that university June 15. The subject for his thesis was The Axisymmetric Flow of a Compressible Gas Through the Radial Turbo Machine.

Baird came to Allis-Chalmers in 1942 following his graduation from the University of Illinois with a bachelor of science degree in mechanical engineering. He received his master of science degree in mechanics from the University of Wisconsin in 1949 after attending evening classes.

* * *

SEVERAL CHANGES in Cooper-Bessemer's engineering organization have been made public by Ralph L. Boyer, Vice President and Chief Engineer. In addition to Mr. Boyer, Vice President and Chief Engineer, and E. Frederick, Assistant Chief Engineer, the Cooper-Bessemer's new Office of Chief Engineer now includes: T. O. Kuivinen, R. F. Kymer and W. R. Crooks as Chief Engineer's assistants.

* * *

THE HOUSTON OFFICE of Leeds & Northrup Company, Philadelphia manufacturers of electrical measuring instruments, automatic controls, and heat-treating furnaces, has been moved to 2480 Times Boulevard, Houston 5, Texas, from its former location, 1314 Texas Avenue.

* * *

THE HELI-COIL CORP. of Long Island City, New York, announces the election of Eugene M. Lang to the position of vice-president in charge of manufacturing. Mr. Lang, former works manager at the Heli-Coil plant, has served the firm in various executive and production capacities since 1941. Prior to this, he was a management consultant to chemical and metal-fabricating firms and an industrial analyst for several trade publications. Louis K. Rimer, former vice-president in charge of operations of Elgin American Co., Elgin, Illinois, succeeds Mr. Lang as works manager and has been elected assistant secretary of the corporation.

* * *

ORVILLE L. LONGBRAKE has been appointed defense regulations engineer for the American Steel and Wire Company, it was announced today by Walter F. Munford, operating vice president. In his new post in the general engineering department, Mr. Longbrake will analyze and interpret government orders and regulations affecting engineering and maintenance operations in the wire company's 14 plants located in nine cities. In addition, he will assist with procurement and correlate information concerned with engineering and maintenance.

* * *

CONSTRUCTION OF NEW general offices and plant facilities of the Crane Packing Co. of Chicago is under way, it was announced by Frank E. Payne, company president. The new plant site, situated on Oakton Avenue near Lehigh in Morton Grove, Illinois, will cover 133,000 sq ft when completed. Architects and Engineers are Olsen and Urbain of Chicago.

* * *

APPOINTMENT OF Luther D. Shank as Deputy director of the Electrical Equipment Division, National Production Authority, U. S. Department of Commerce, was announced lately. Mr. Shank is on leave as Philadelphia district manager of the Appleton Electric Co., Chicago. Joining NPA in November 1950, he was formerly Chief of the Electrical Products Branch, Building Materials Division.

* * *

C. W. BELL, SR., for many years Assistant to Superintendent of Generation, Pennsylvania Power & Light Co., retired from that company on January 31, 1951. He has now opened his own office as Engineering Consultant at 336 W. Maple Street, Hazleton, Pa. He specializes in central heating and power plants, plant layouts, operation, maintenance, rehabilitation, electrical applications and maintenance, and lubrication.

* * *

ELECTION of I. Melville Stein to the newly created post of Executive Vice-President is announced by the directors of the Leeds & Northrup Co., Philadelphia, Penna. Mr. Stein has been a vice-president, and is Director of Research.

* * *

A. H. BORCHARDT has been elected a vice president of Worthington Pump and Machinery Corp. He has been successively sales manager of the Harrison plant, manager of the Commercial Engineering Department and, in 1934, Assistant Vice President and Manager of Centrifugal Pump Application and Sales Division.

A WATER SOFTENER THAT HAS EVERYTHING

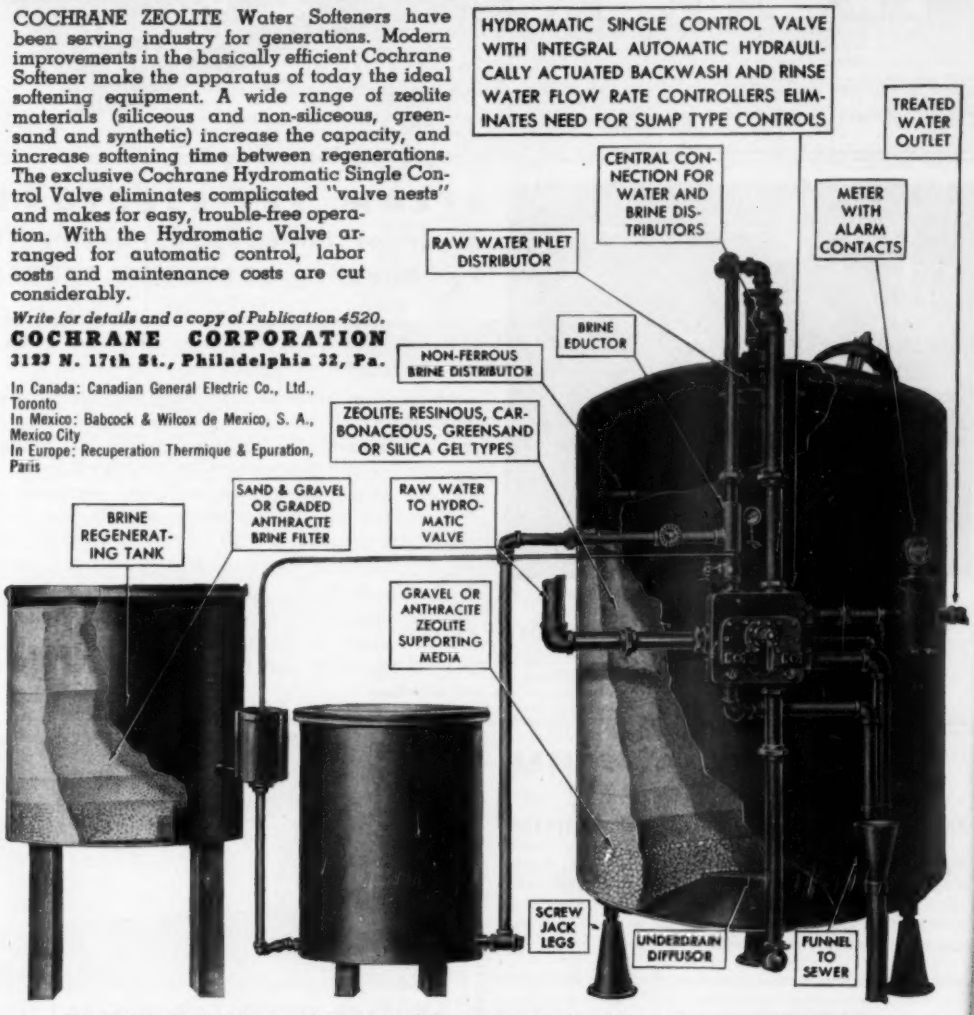
WIDE RANGE OF ZEOLITES • HYDROMATIC VALVE • AUTOMATIC CONTROLS
PLENTY OF SOFT WATER • LONGER TIME BETWEEN REGENERATIONS • SAVE ON LABOR

COCHRANE ZEOLITE Water Softeners have been serving industry for generations. Modern improvements in the basically efficient Cochrane Softener make the apparatus of today the ideal softening equipment. A wide range of zeolite materials (siliceous and non-siliceous, greensand and synthetic) increase the capacity, and increase softening time between regenerations. The exclusive Cochrane Hydromatic Single Control Valve eliminates complicated "valve nests" and makes for easy, trouble-free operation. With the Hydromatic Valve arranged for automatic control, labor costs and maintenance costs are cut considerably.

Write for details and a copy of Publication 4520.

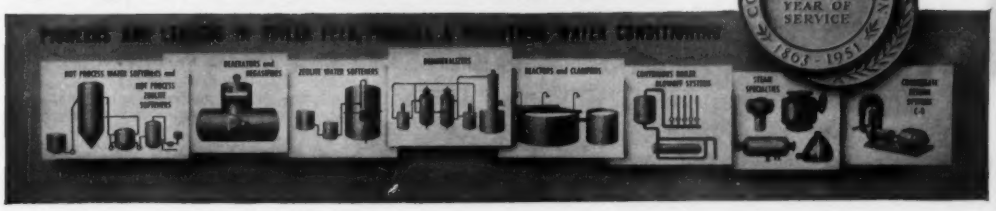
COCHRANE CORPORATION
3123 N. 17th St., Philadelphia 32, Pa.

In Canada: Canadian General Electric Co., Ltd., Toronto
In Mexico: Babcock & Wilcox de Mexico, S. A., Mexico City
In Europe: Recuperation Thermique & Epuration, Paris


HYDROMATIC SINGLE CONTROL VALVE WITH INTEGRAL AUTOMATIC HYDRAULICALLY ACTUATED BACKWASH AND RINSE WATER FLOW RATE CONTROLLERS ELIMINATES NEED FOR SUMP TYPE CONTROLS
TREATED WATER OUTLET
CENTRAL CONNECTION FOR WATER AND BRINE DISTRIBUTORS
METER WITH ALARM CONTACTS
RAW WATER INLET DISTRIBUTOR
BRINE EDUCTOR
NON-FERROUS BRINE DISTRIBUTOR
ZEOLITE: RESINOUS, CARBONACEOUS, GREENSAND OR SILICA GEL TYPES
SAND & GRAVEL OR GRADED ANTHRACITE BRINE FILTER
RAW WATER TO HYDROMATIC VALVE
BRINE REGENERATING TANK
GRAVEL OR ANTHRACITE ZEOLITE SUPPORTING MEDIA
SCREW JACK LEGS
UNDERDRAIN DIFFUSOR
FUNNEL TO SEWER

The Cochrane Zeolite Softener with Hydromatic Valve arranged for Manual Operation

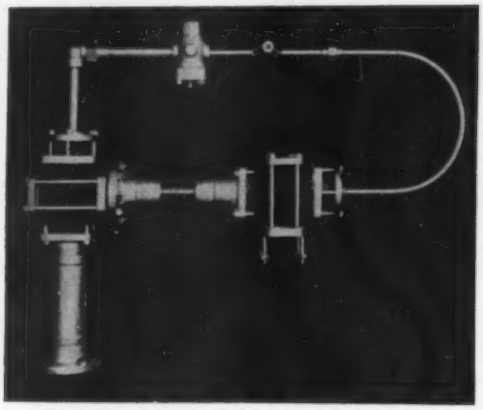
COCHRANE



NOTES for the Power Engineer

C. H. Wheeler OF PHILADELPHIA

STEAM CONDENSERS—STEAM JET EJECTORS—COOLING TOWERS—VACUUM REFRIGERATION—HIGH VACUUM PROCESS EQUIPMENT—MICRO-PARTICLE REDUCTION MILLS—MARINE CONDENSERS & EJECTORS—DECK MACHINERY



Two-stage non-condensing impervious graphite ejector

Send for catalog 1462. It contains helpful tables and tips on Steam Jet Vacuum problems. It also describes the complete line of C. H. Wheeler Tubejets. It will be mailed at no obligation to you.

STEAM JET EJECTORS
Made of IMPERVIOUS GRAPHITE For Handling CORROSIVE VAPORS

If your vacuum equipment is inefficient due to corrosion from acid fumes, this item holds an answer to your problems.

For highly corrosive acids such as sulphuric, hydrochloric, nitric, etc. C. H. Wheeler impervious graphite ejectors are recommended. The impervious graphite is enclosed in a steel or cast iron casing to prevent breakage. It is light in weight, non-porous, with low coefficient of thermal expansion and high resistance to thermal shock. Impervious graphite is most commonly recommended for the single and two-stage non-condensing ejectors.

C. H. Wheeler Ejectors can also be furnished of other materials such as acid resisting bronze, monel and stainless steel where the corrosive action of the vapors being handled does not require the use of impervious graphite construction.

"SELF-CLEANING" CONDENSERS by REVERSE FLOW featured in C. H. WHEELER Bulletin

The C. H. Wheeler Manufacturing Company's unique design of an integral reverse-flow steam condenser provides the most practical method yet devised for cleaning the tube sheet, and eliminates the need for expensive mechanical water straining apparatus. A recently issued bulletin tells how it works.

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Attach this Handy Form to Your Company Letterhead

Interested in following literature

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- ☐ "Self-Cleaning" Reverse-Flow Steam Condensers

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Your Job .....

(Literature will be mailed to address shown on your company letterhead)

ANOTHER TOWER FOR SAN ANTONIO
13 Cell, 55,000 GPM Capacity to be Built by C. H. Wheeler for Gibbs & Hill, Engineers & Constructors

Following construction of two 7-cell Cooling Towers at the Leon Creek Power Station of San Antonio, Texas, C. H. Wheeler has been awarded the construction of a third and larger tower. The first towers were designed for 30,000 GPM. The new tower will handle 55,000 GPM to serve a 60,000 KW generator. It is a 13-cell induced-draft tower designed for 76.5° wet bulb, taking water at 105.5° inlet and cooling it to 90° outlet. Proposed construction is 39'8" x 364' x 29'. It will resist 30 lbs. per square inch wind pressure, or 100 mph hurricane force. Gibbs & Hill, New York are the engineers and constructors on the job.

C. H. WHEELER MANUFACTURING CO., 1802 SEDGLEY AVE., PHILADELPHIA 32, PA.

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(*Continued from page 138*)

275 Packing Rings — Engineering data on company's Simsite Graphitic snap rings of non-metallic composition for packing liquid end pistons of reciprocating pumps is provided in illustrated Bulletin R112. Covers properties of Simsite, forms of packing spaces, ordering information needed, installation procedure. Sims Pump Valve Co., Inc.

COAL, ASH, AND WASTE HANDLING

276 Spreader Stoker Selection — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

277 Spreader Stoker Data — This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

278 Coal Scale — Bulletin 0250, 12 pp, describes a pressure-tight, automatic coal scale, its construction and operation. Shows how beam system, electrical components and linkages are protected from exposure to coal dust. Richardson Scale Co.

279 Efficient Coal Preparation — Facts on improved coal preparation for power plants are presented in this 8-pp illustrated booklet. Shows how coal is split, not crushed, by rolling ring principle utilized in company's equipment to provide better combustion and reduced ashpit loss through uniform low-cost coal sizing. American Pulverizer Co.

280 Spreader Stoker — Bulletin 890, 40 pp, describes a spreader stoker with overthrow rotor designed to provide uniform fuel distribution. Discusses advantages, including efficiency in burning many grades of coal and handling fluctuating loads. Power-operated and hand-operated dumping grates, stationary grates shown. Detroit Stoker Co.

281 Ash Handling Systems — This 24-pp booklet offers technical information on hydraulic and pneumatic ash and fly-ash handling systems. Compiled in question and answer form. Discusses elements and advantages of various systems and disposal schemes. Schematic drawings of arrangements under specific conditions, diagrams of arrangements included. Beaumont Birch Co.

282 Coal Handling Equipment — Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated, covers concrete and tile silos, cylindrical steel tanks, suspended steel bunkers. Gifford-Wood Co.

283 How to Cut Waste Costs — A factual treatise, "Four Ways to Economize on Industrial Wastes," discusses briefly main types of industrial wastes and special problems involved in their handling. Explains ways of coping with waste costs by reduction of waste volume, by improved processing methods, by conversion of wastes to by-products and by treatment. Gilbert Associates, Inc.

PUMPS AND COMPRESSORS

284 Compressor Selection Chart — Based on normal applications handling air with atmospheric intake pressure, this chart simplifies selection of proper size compressor, giving quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute. Shows recommended compressor bore and stroke in inches. Worthington Pump and Machinery Corp.

285 Boiler Feed Pumps — Bulletin 109, 16 pp, illustrated in color, describes centrifugal pumps for boiler feed service. Pictures construction and major parts, float-

GOOD TEMPERATURE REGULATION MEANS FEWER HEADACHES

In Power Plants all over the world, you will find Foster Temperature Regulators controlling temperatures of liquids and gases on heating and cooling equipment such as fuel-oil heaters; storage type water heaters, evaporators and cooling systems. The reason for this acceptance is that they offer a simple, dependable answer to accurate, automatic temperature control. They do their job well, with a minimum of maintenance.

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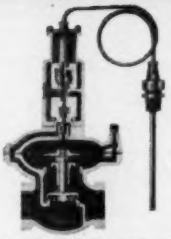
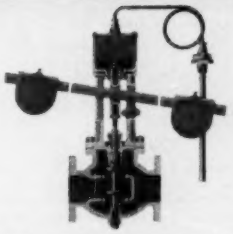
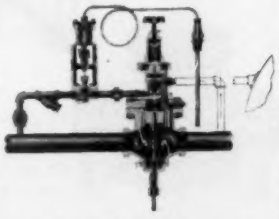


The Foster Type 34-T controls temperatures within approximately 1° F plus or minus, using steam or gases as heating medium. Internally pilot-operated, diaphragm actuated; valve travels from shut-off to full opening with relatively small temperature change.



The Foster Type T-3 controls temperatures within 3° to 5° F, plus or minus, using steam, water or other liquids and gases as heating or cooling medium. Handles large volumes with low pressure drop across double seats.

The Foster Type T-4 controls temperatures within plus or minus 5° F, using small volumes of steam, water or other liquids or gases as heating or cooling medium. Direct-acting, single seated for tight shut-off.



The Foster Type T-10 combination temperature and pressure regulator permits safe use of steam at pressures considerably higher than the shell of the heated vessel is built to withstand. Adjustable for both temperature and pressure.

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ing seal incorporated. Capacity data, vapor pressure tables included. Pacific Pumps, Inc.

286 Pulsation-Free Compressor Piping — Illustrated Bulletin PDS-8501, describes company's pulsation dampening piping system. Tells how this piping affords higher operating efficiency, other advantages. Explains pulsation phenomena in compression systems. The Fluor Corp., Ltd.

287 Data on Pumps — All Types — Bulletins are available on centrifugal, reciprocating, screw and rotary pumps covering a wide range of capacities and services. Includes information on single and multistage, close coupled, single and duplex piston, and special pumps for handling erosive and corrosive liquids, also high viscosity liquids, both lubricating, non-lubricating. Warren Steam Pump Co., Inc.

HEATERS, HEATING

289 Water Heaters — Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-, four- and six-pass designs, with tube bundles removable. Davis Engineering Corp.

290 Heat Exchangers — Bulletin 114, a small folder, gives concise information on company's Aero heat exchanger with balanced wet bulb control designed to cool engines or process equipment, coolants and lubricants, liquids and gases for processing operations. Niagara Blower Co.

291 Heat Exchangers — Bulletin '11.0.-080 describes air cooled heat exchangers for condensing or cooling of steam or process vapors, natural gas, jacket water, lubricating oil, quenching baths. Equipment Div., J. F. Pritchard & Co.

COOLING

292 Cooling Towers — Bulletin AQ-50 is on packaged water cooling towers in 3 to 50 t sizes. Gives specifications for the tower and discusses special features. Also provides dimensional and application data covering the five standard and three large sizes. The Marley Co., Inc.

293 Spray Nozzle Systems — Recooling spray nozzle systems for use in plants operating condensers or using large quantities of water for cooling, are covered in 8-pp Bulletin 6A-8P. It details design, application, construction, and operation of spray nozzles, and diagrams typical spray pond arrangements. Sizes, dimensions, capacities, and spray nozzle patterns are included in tabular form. A temperature graph gives cooling performance curves for spray nozzles for various temperature ranges using 7 psi at nozzle. Schutte and Koerting Co.

294 Cooler with Fins — A new oil and water cooler and advantages of its improved design are described in 20-pp Bulletin 1020. Explains how company's LK-Fin Cooler, distinguished by use of helically-finned heat transfer elements instead of bare tubes, is a lighter, more compact and less costly unit. Diagrams show comparisons of length and number of tubes and size of units for equivalent heat transfer surface. The Griscom-Russell Co.

DUST CONTROL

295 The Efficiency of Decantation — The decantation principle as applied in dust control systems and how it separates high carbon content particles from fly ash for re-injection as fuel is discussed in illustrated Catalog 260D. A typical installation is diagrammed and efficiency curves included. The Thermix Corp., Prat-Daniel Corp.

296 Fly Ash Elimination — This 30-pp booklet presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash — not as a panacea for all cinder and fly ash problems. Also gives data on single and double hopper installations. Western Precipitation Corp

297 Dust Collecting Efficiency — How the higher and narrower inlet utilised in company's tubular dust collector improves dust collecting is explained in this illustrated bulletin. Prat-Daniel Corp.

FANS, BLOWERS

298 Mechanical Draft Fans — Mechanical draft fans for both forced and induced draft service are described in 20-pp Bulletin 168. Illustrated with drawings of typical fan types and photos of installations, includes performance curves showing efficiencies of various types of fans. Gives construction features, drive arrangements, mounting methods. The Green Fuel Economiser Co., Inc.

299 Blowers and Accessories — Engineering and dimensional information on low, medium and high capacity blowers is given in this 6-pp bulletin. Pictures some installations, also accessories. Blower-Stoker Div., Read Standard Corp.

300 Axial Flow Blowers — In this 6-pp illustrated bulletin are described axial flow blowers of both turbine-driven and motor-driven types. Gives capacity and dimensional data, operating range and specifications on both types. L. J. Wing Mfg. Co.

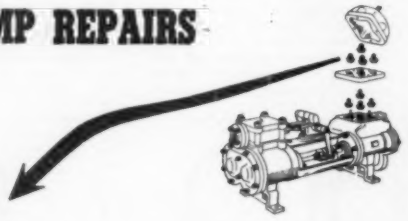
CONDENSERS

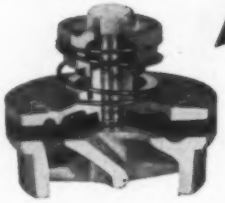
302 Steam Condensers with Reserve Flow — Eight-pp Catalog 410-1 describes a "self-cleaning" reverse-flow condenser for power plant service, designed to virtually eliminate cleaning down time and, in the case of divided water box condensers, eliminate operation at partial load. C. H. Wheeler Mfg. Co.

303 Ejector Instruction Manual — Bulletin J-50-7 is a 36-pp handbook covering operation, selection, installation and

(Continued on page 158)

REDUCE PUMP REPAIRS 4 WAYS





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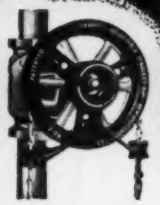

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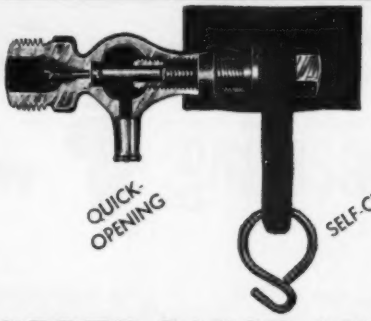

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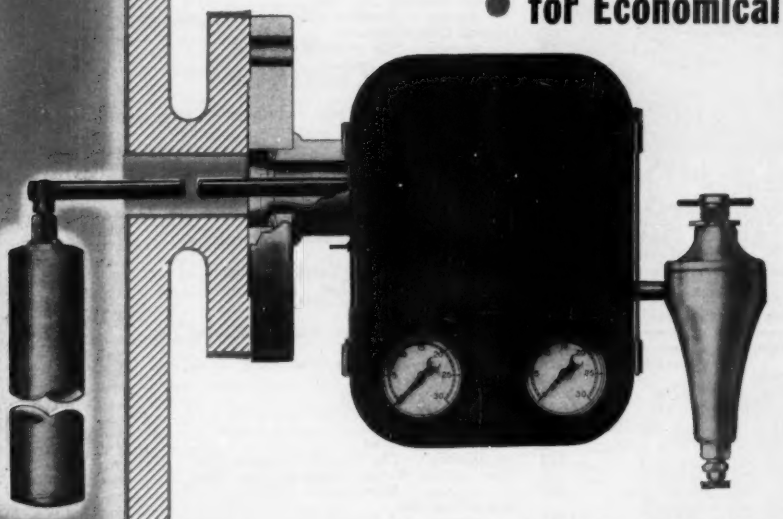

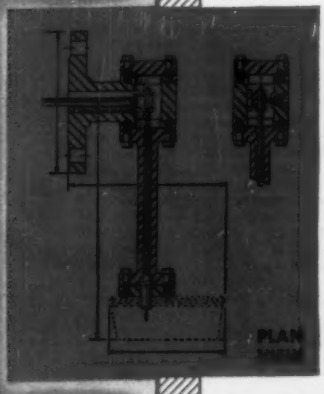

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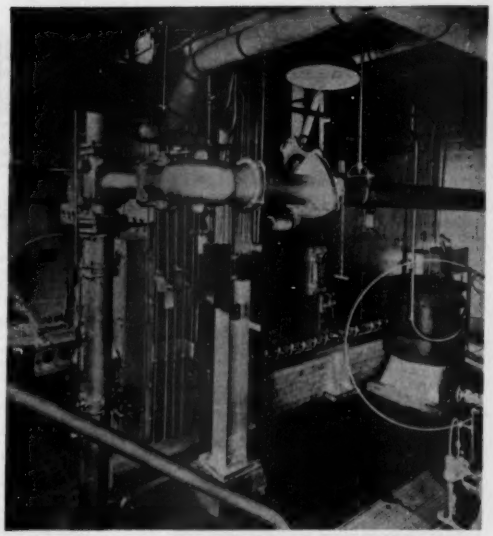

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304 Steam Condensers — Bulletin 102, 24 pp, presents manufacturer's steam condensers and includes photos of typical installations as well as engineering data, discussion of air removal equipment, and chapter on condenser maintenance. Company's Wizard injector to seal small leaks while condenser is in operation, air erosion eliminators, divers lights and port gages are also described. Condenser Service & Engineering Co., Inc.

METALS

305 Steels for Hot Spots — This is an 88-pp manual on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical properties of 21 steels. United States Steel.

306 Bibliography on Nickel Alloys — Sixteen-pp List A covers company's technical papers and commercial publications available on nickel alloy steels, stainless steels, nickel cast irons, nickel brasses and bronzes, and nickel plating, and their uses. The International Nickel Co., Inc.

OTHER EQUIPMENT

307 The ABC of CO_2 — An interesting text covering role of carbon dioxide in combustion efficiency, 16-pp illustrated Bulletin 452 discusses theoretical vs practical perfection of combustion and tells how to determine percentage of CO_2 in flue gases. CO_2 as a basis for figuring heat and fuel losses is also described and method of determining such losses explained. Includes scales of total heat losses of various types of coal, fuel oils and gas. The Hays Corp.

308 Transmission Belting — Catalog M-9922, 28 pp, gives design, engineering and performance data on transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors included. United States Rubber Co.

309 Turbine Catalog Collection — This is a valuable collection of bulletins covering a complete description of solid wheel turbines. They feature cross section drawings of typical units for both moderate and high steam pressure conditions. Includes data on speed increasing and reduction gears. The Terry Steam Turbine Co.

310 Paints to Beat Corrosion — This 8-pp illustrated bulletin on anti-corrosive paints discusses their sub-oxide of lead base and other technical properties and points out economy of these rust-inhibitive coatings. Describes primers, finishing coats and single coats available; tells how to apply them. Also discusses painting of galvanized structures. Subox, Inc.

311 Dehydration Systems — This bulletin presents pressure type and gravity type dehydration systems for cleaning, stabilizing, and degasifying lubricating oils. Explains features, operation. Illustrated; includes specifications. Bowser, Inc.

312 Industrial Insulations — Selection and application information on insulating materials is presented in this 28-pp illustrated catalog. Covers block and blanket insulations, insulating cement, low pressure coverings, felt, other products. Gives specifications, temperature ranges, recommended thicknesses, prices; tells how to apply each type, where to use it. Baldwin-Hill Co.

313 Chemical Feed Systems — Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of Bulletin 4811. Explains automatic control. Milton Roy Co.

314 Processing Equipment — Twelve-pp Bulletin 50-1 illustrates and describes equipment designed and manufactured for the process industries. Material is grouped according to use for which equipment is designed. Infilco Inc.

315 Fundamentals of Hydraulics — Technical Bulletin B-4 is a newly revised 44-pp guidebook covering essential information on hydraulic systems, maintenance trouble-shooting and selection of proper fluids. Besides offering reference data to engineering personnel, this book is suggested as a training manual for maintenance supervisors, operators. It features specially prepared phantom and cutaway drawings illustrating functions of basic types of valves, pumps, hydraulic motors, torque converters. Sun Oil Co.

316 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces, where steam or compressed air is available for atomizing the oil. Discusses steam and oil control valves, design and construction of furnaces in which fuel oil is burned, register and tandem types combustion units. National Airoil Burner Co., Inc.

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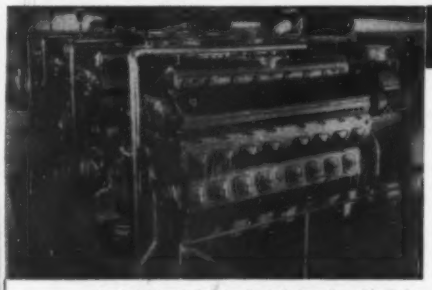

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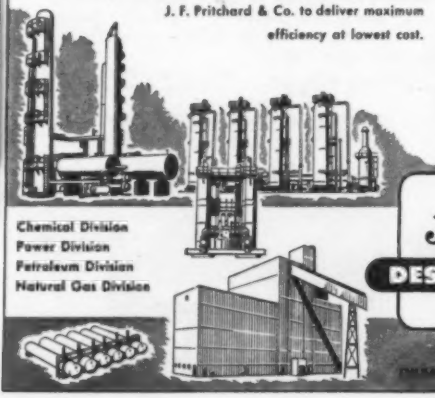

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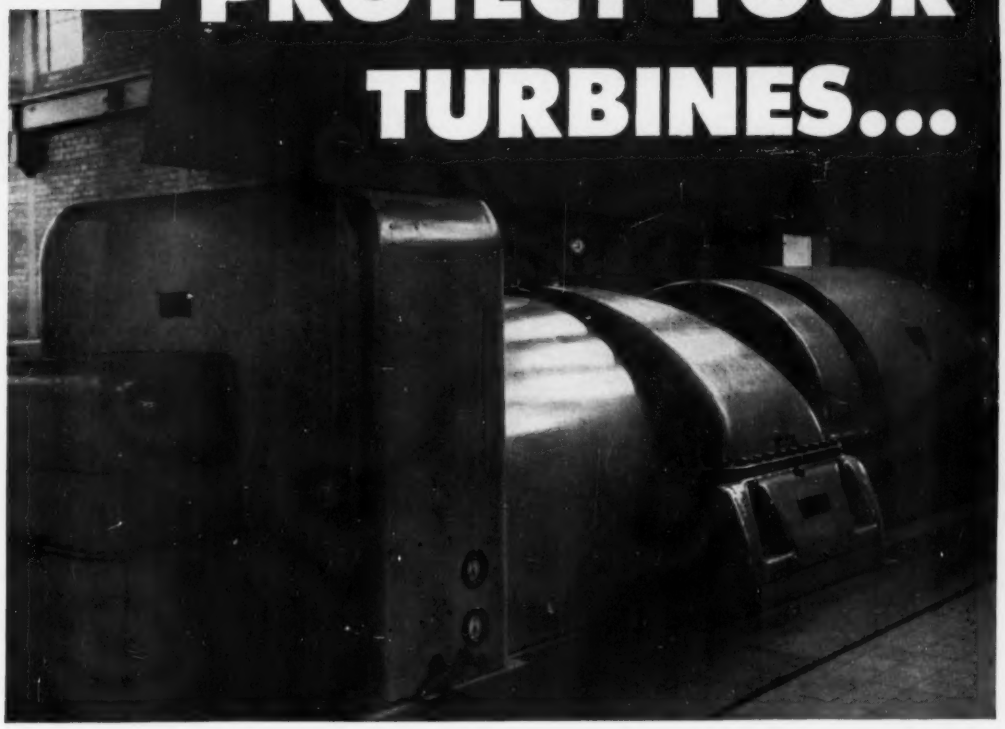

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